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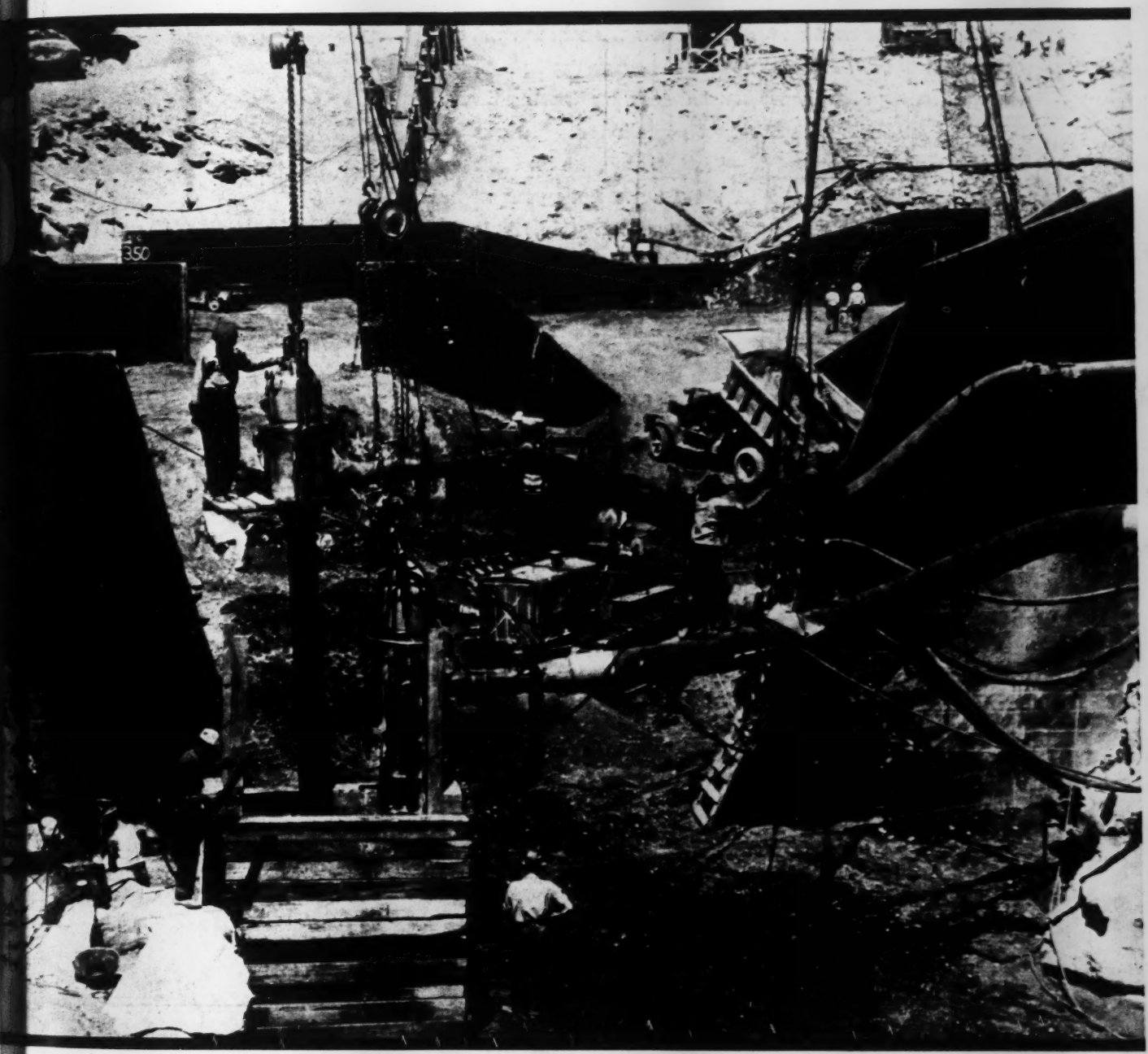
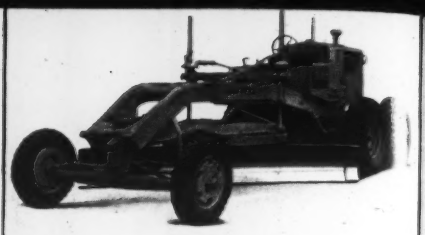
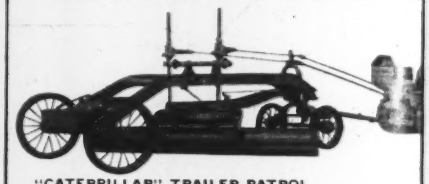


Beginning the fill for Alcova Dam in Wyoming. Beyond the subdrainage pumps are bulldozers and sheepsfoot rollers working between cutoff walls in a deep channel in the foundation rock.

ALL YEAR ROUND, IT'S FIRST ON THE ROADS

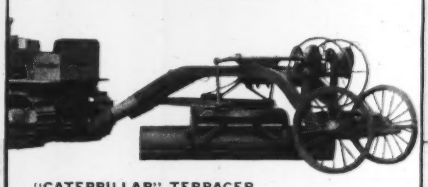


"CATERPILLAR" DIESEL AUTO PATROL



"CATERPILLAR" TRAILER PATROL

"CATERPILLAR" ELEVATING GRADER



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ROAD MACHINERY

REG. U. S. PAT. OFF.

Salute!

To the 23rd Engineers

ON PAGE 44 of this issue the Reunion Committee of the 23rd Engineers sounds off for its first national assembly since the outfit was disbanded in 1919. And thereby hangs a tale that is of peculiar interest to the staff of this journal.

It appears that back in 1917 the army was trying to raise an engineer regiment to specialize on highway construction and maintenance in the service of the A.E.F. Recruiting had not been going particularly well. Thousands of men doubtless were competent and willing to serve if they could but be found and told of the need. But after the fashion of construction men they were scattered the length and breadth of the land, working on thousands of jobs and living in thousands of towns and camps.

To reach them by any popular dragnet did not seem to work: too much waste of time, effort and cash; especially of time, that most important of all war munitions. Any appeal through a popular medium or channel was so diluted as to be lost in the welter of distracting popular interests. It just did not seem to reach and stimulate the particular men that were sought. Indeed, the recruiting problem of the 23rd Engineers was not one of popular interest. It was one of searching out, segregating and talking directly to the engineers and construction men of the country who might be fit, competent and willing to embark upon a roadbuilding adventure of historic import.

What to do?

Just then someone had an attack of the obvious. Why not seek out and talk to these men through the very channel that was maintained for that purpose? Why not use a screen that was set automatically to segregate them from the millions of their fellow citizens? Why not talk to them through the pages of a journal that week after week sought them out wherever they might be hidden and spoke to them of their own affairs in their own language? In short, why not enlist *News-Record* as recruiting officer for the regiment?

No sooner said than done. Through this journal an appeal was broadcast to the roadbuilders of America. Many patriotic producers of materials and machinery cooperated through their advertising to reinforce that appeal.

The response was as immediate as it was amazing. Throughout the land hundreds of engineers and construction men dropped what they were doing to write, wire or set right out for recruiting headquarters. In no time at all several thousands had applied from whom the ranks of the regiment quickly were filled. In the language of finance: "the issue was many times oversubscribed."

So well had *Engineering News-Record* performed as recruiting officer that its services later were invoked to help enlist other engineer units. But its first and most dramatic effort in that rôle was in behalf of the 23rd Engineers—the roadbuilders—and so today, as the men of that outfit are about to reassemble at Cleveland, we of the *News-Record* staff halt in the day's march long enough to salute them and to wish for them a delightful and happy reunion.

Willard Chevalier

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Scene from Warner Bros. picture "Earthworm Tractors" starring Joe E. Brown with June Travis and Guy Kibbee, based on stories about Alexander Botts, Earthworm Tractor Salesman, by William Hazlett Upson, published in The Saturday Evening Post. (*"Caterpillar Diesel Tractors" were used*).

"Earthworm Tractors" and Inland Steel Star with Joe E. Brown

Joe E. Brown's latest comedy, "Earthworm Tractors", demonstrates the reason why "Earthworm Tractors" are so popular in such rough-and-ready industries as logging, mining, construction, etc. In showing their own amazing strength and stamina, "Earthworm Tractors" also testify to the quality of Inland Steel, for Inland Steel is used extensively in the building of these machines.

Inland has worked with "Earthworm" for many years, supplying an increasing tonnage of bars, shapes, plates, and sheets to keep up with the growing demand for these powerful tractors.

The well-known Inland *Safety* 4-Way Floor Plate is shown in the smaller photograph at the right.

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Black Ribbons of Travel—To serve the scattered population of their wide-open spaces with mudless, dustless means of travel at a cost that will not be burdensome, the States west of the 100th meridian have built thousands of miles of bituminous roads. The highway departments of these states are fountains of knowledge in the field of black top. Next week, a bituminous conference sponsored by Montana will subject much of this knowledge to expert scrutiny. This week, News-Record publishes an article describing Montana's black ribbons of travel.

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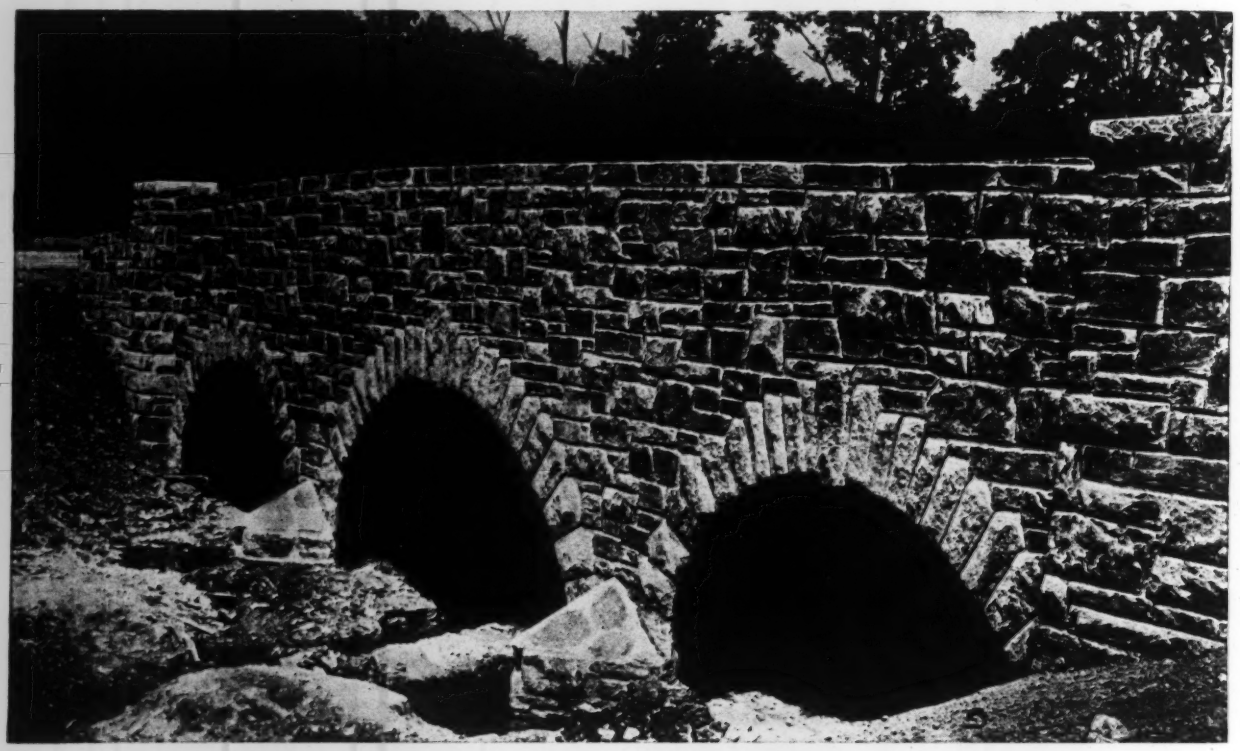

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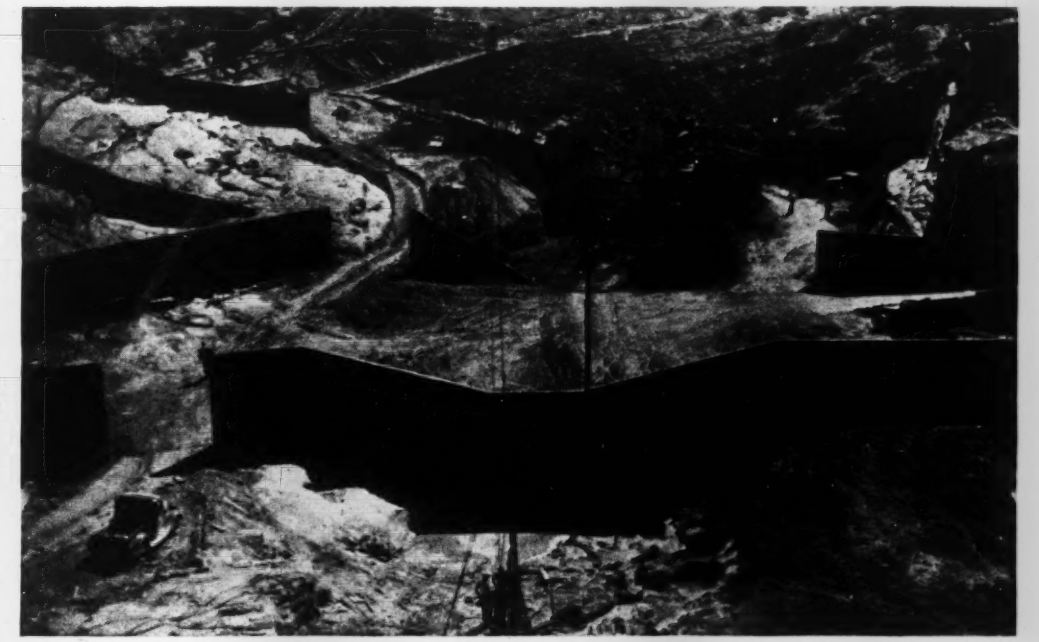
UNITED STATES STEEL

ENGINEERING NEWS-RECORD

September 3, 1936



THREE MAIN CUTOFF WALLS are seated in solid rock and extend 14 to 20 ft. upward into the impervious earth fill.

Grouting Seals Alcova Dam

Ten miles of grout holes sunk into water bearing foundation rock to form blanket and curtain walls.—Cutoffs of concrete built above the rock surface with curtains of grouted rock below to stop seepage under the compacted earth-fill section of the dam.

EXTENSIVE BLANKET and curtain wall grouting has almost completely sealed off the hot springs and numerous leaks through the seamy rock foundation of the Alcova Dam of the Casper-Alcova Irrigation project in Wyoming. An aggregate of ten miles of holes has been drilled and more than 200,000 cu.ft. of grout has been forced into them. Making the foundation of this dam tight so that an earth fill could safely be placed on it was considered one of the most serious engineering difficulties of the whole project.

The system adopted was first to drill and grout a line of holes in the canyon floor along the sides and upstream edge of the dam to form a grout curtain wall. This "rim" was followed by a "blanket" of shallow regularly spaced holes making a surface "shell" through which deep holes were drilled to the lower cavities and seams, which were sealed under 150 to 200-lb. pressure. In addition, three grouted curtain walls extending across the canyon floor and up the abutments are surmounted by concrete cutoff wall that will extend up into the fill.

The Alcova Dam is to be a compacted impervious earth-fill dam supported and protected by outer sections of pervious material taken largely from the diversion tunnel, spillway and river bed and the abutment strippings. Its purpose is largely for diversion of the North Platte River into the main irrigation canal. It will raise the level of the water in the river 170 ft. so that it will enter the headgates of the 60-mile Casper canal now under construction to supply irrigation water to 35,000 acres of land lying to the northwest of Casper. Only stored storm water in the Pathfinder reservoir and that to be stored behind Seminoe dam will be available for this project. The 160,000 acre-ft. stored back of the Alcova Dam can, however, be used as exchange water, drawing down the upper reservoirs late in the season after the Casper season has closed.

A general description of the project was published in *ENR* of Aug. 31, 1933, p. 251, and Nov. 29, 1934, p. 698; later, in *ENR* of Feb. 14, 1935, p. 250, the construction of the diversion tunnel and difficulties encountered with the hot springs were noted. During the irrigation season this tunnel passed nearly 5,000 sec.-ft. of water from the Pathfinder Dam around the construction work at Alcova Dam. Another article, Sept. 19, 1934, p. 385, describes the main canal headworks and the tunnels and siphons.

The present article relates to the dam, chiefly to the stripping and sealing of the extremely leaky foundation, careful placement and compaction of a central core of impervious embankment over the sealed area, an elaborate system of concrete cutoff walls, an inspection and drainage gallery to which a downstream drainage system is tributary and borrow pit operation producing the necessary graded and moistened embankment material.

In the drawings are shown the segregations of the dam materials, including the lower cofferdam which was made up

largely of the diversion tunnel excavation. The spillway has been partially excavated in rock at the north end of the dam and the excavated material has been placed in the bottom of the rockfill portion of the dam. The cross-section shows the position of the grout holes and their penetration of the standstone overlying the ledge rock limestone. The drainage gallery will be seen to be about 60 per cent in tunnel extending under the full length of the structure and to have a shallow grout curtain wall below it to prevent seepage from downstream passing upstream under the impervious section. A line of deep drainage holes will relieve pressure from hot water below the dam and conduct it into the gallery.

Stripping the site

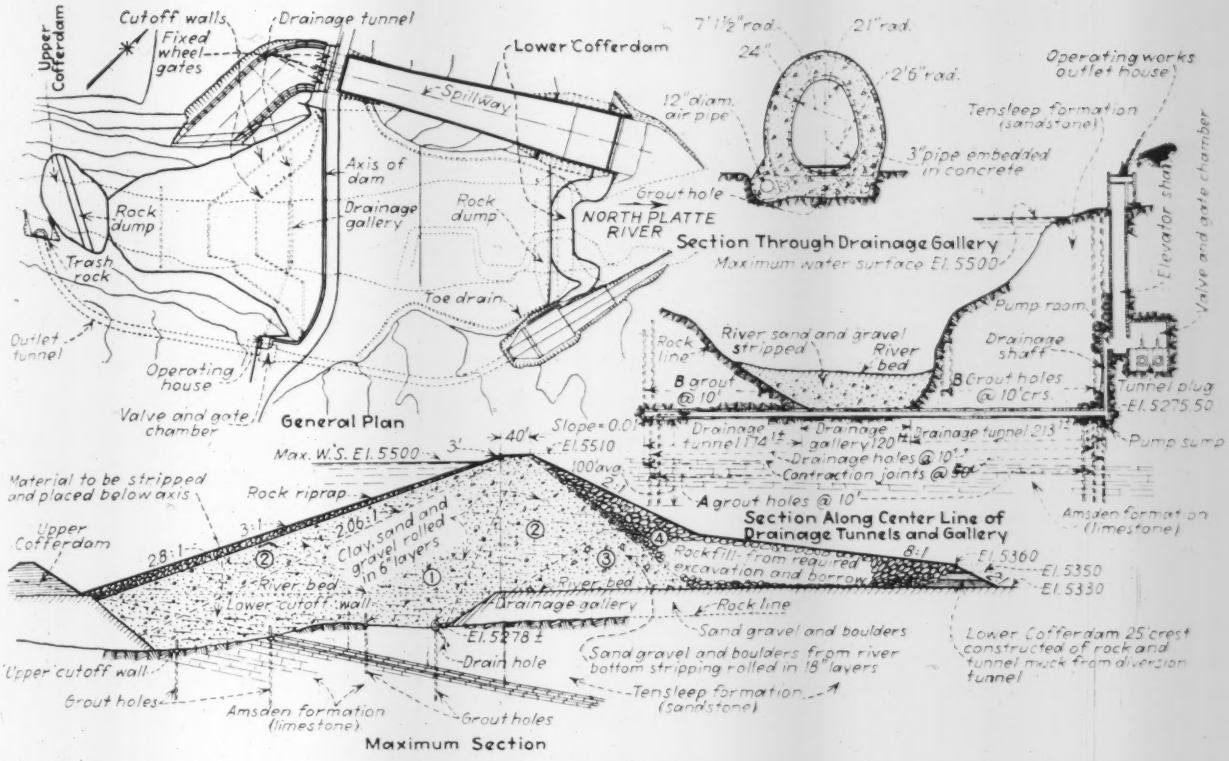
Although not completed until April, much of the stripping and laying bare of the bedrock was done late last fall and winter utilizing a 2-yd. shovel which loaded 5-yd. trucks. A 1-yd. drag or shovel was used as a general purpose machine and for the final clean up a ⅜-yd. shovel was available. Much of the final cleaning of the rock surface, especially at side walls and in pot holes, was hand work. As noted on the cross-section of the dam, most of this material went into the pervious downstream portion of the dam.

Two unexpected features were found as the bedrock was uncovered. Near the center of the channel a deep chasm was disclosed, 50 ft. wide, 60 ft. deep at the upstream toe and only 6 ft. deep on line with the drainage gallery. It was 30 to 40 ft. wide at the bottom. Apparently it had been eroded below a water fall. This "plunge basin," after it had been excavated, was utilized as a drainage sump, two 2,000-g.p.m. pumps being suspended over it by cables secured to anchors in the canyon walls. As the upstream slope of the excavated area, lying directly below the upstream cofferdam, was not tight the contractor dammed off the low end with stop logs and finally built a tight concrete wall across the upper end 18 ft. upstream from the line of the upper cutoff wall. This wall aided materially in the construction of the cutoff footings and the subsequent placing of earth embankment in the dry. At the plunge basin the cutoff wall has the appearance of a giant U since the wall was nowhere more than 14 to 20 ft. above the rock surface.

The second unexpected feature in the foundation was a large rock cavity filled with comparatively dry, hard packed sand under some 18 ft. of solid rock forming the normal rock bed of the river. This cavity was discovered in drilling a grout curtain wall under the upper cutoff wall 50 ft. south of the plunge basin. It was 20 ft. long on the line of the cutoff, 10 to 20 ft. wide and 20 ft. maximum depth. Blanket drill holes, 10 ft. each side of the cutoff, did not strike the cavity. The cavity was excavated by drifting into

THE PLUNGE BASIN is deepest in foreground (upstream end) decreasing to a depth of 6 ft. at lower end under far cutoff wall. The drainage conduit is beyond downstream cutoff wall. This picture was taken prior to placing any earthfill.

A BULLDOZER spread the filling material into the deep corners of the plunge basin. In the foreground are two pumps suspended over the sump pit to keep them free of the filling operations.



ALCOVA DAM is an earthfill structure with large central section of impervious compacted clay and gravel. Excavation from diversion tunnel and spillway practically all went into dam.

it from a nearby sump. Concrete was then poured into it through a 6-in. well drill hole. To insure filling to the top, which was at the contact point between the limestone and sandstone formations, grout was forced in. Some 125 yd. of concrete was required to fill the cavity. From the leached appearance of the floor and sides, the cavity might have been the result of the passage of the hot water dissolving out the limestone. This theory is supported by the observation that the cavity was entirely surrounded by solid rock. On the other hand shallow sandy seams were encountered upstream from the cavity in drilling blanket grout holes. Laboratory analysis showed, "Sand grains mostly rounded, mostly of granite, with few black grains, and a little pyrites and garnet." From this observation, the sand appears to have been deposited in the cavity by filtering into it through rock seams.

Drilling and grouting

Following stripping, and coincident with much of it, pumping was continuous. The seepage from upstream and downstream river bed overburden as well as the small seepage through the rock foundation was handled by one and sometimes two 2,000-g.p.m. pumps. Pumps were choked down or operated intermittently. Drilling and grouting started Sept. 25 of last year. Most of this work for the dam foundation was completed in June, the springs, leaks and seepages having by that time been reduced to a few gallons per minute at the worst spots. Because of the leakage through the bed materials under the cofferdams it was impractical to measure the springs and rock seeps. On the last of June the total amount of remaining leaks through the rock foundations for the earth-fill portion of the dam was estimated at 8 g.p.m.

The plan was first to drill and grout a U-shaped curtain about the three sides of the excavated area extending upstream from near the axis along the abutments and across the upstream toe of the dam so as to form a tight curtain. Shallow holes 25 to 30 ft. deep were low-pressure grouted and then deepened to 100 and 150 ft., with a few 200 ft. deep, and high-pressure grouted. If much grout was forced into the holes the cement was allowed to set and the drilling for greater depths went through the set grout. Usually the grout was simply washed out before it had time to set.

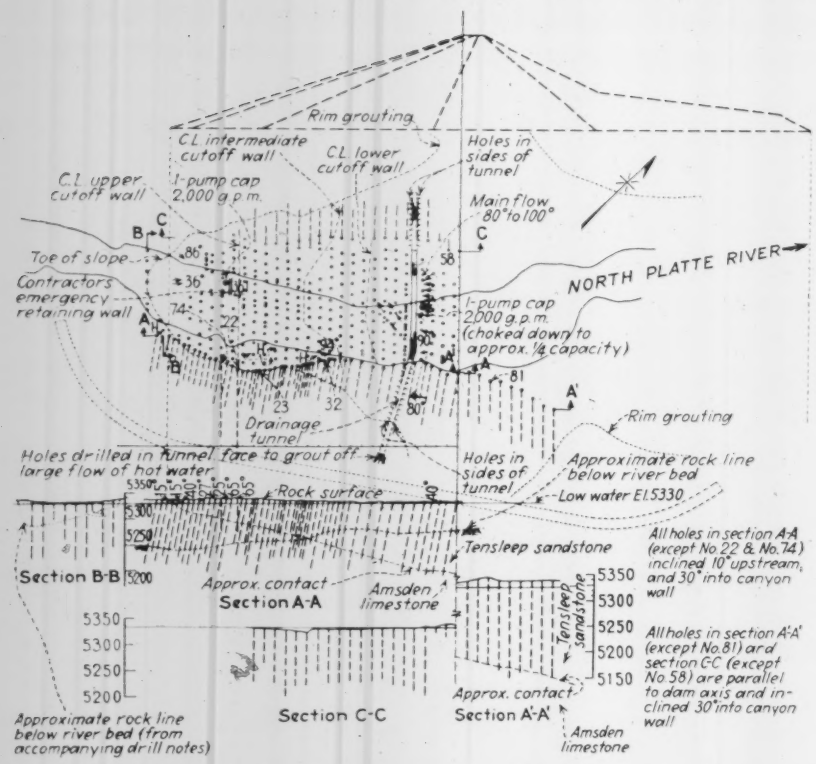
Following this U-shaped curtain, blanket drilling and grouting was done over the whole floor at 20-ft. spacing both ways to form a sort of shell over the area cut off by the curtain. If areas were especially porous intermediate holes at 10-ft. spacing were added.

Across the floor and up the side abutments additional curtains were then grouted, working from trenches, 2 ft. deep and 3 ft. wide, excavated for the footings of concrete cutoff walls that were to extend up into the fill. Three cutoffs were planned originally but several intermediate ones have been added to care for the more seamy rock sections and also in places where the canyon walls overhang. Extreme care was taken to insure that no seepage should occur along the connection between the rock surface and earth embankment. Under the upper cutoff wall the grout holes were spaced on 5-ft. centers. For the intermediate and lower cutoffs a 10-ft. spacing was used.

Rock seams from which grout exuded were caulked. For some last leaks gravel pockets were capped with concrete cones through which grout pipes extend upward. Earthwork around the pockets was then purposely left low and finally brought up quickly and compacted around the pipe. Thus the fill did not become saturated at the rock surface. The pockets were grouted through the pipes when the fill would withstand 25 to 30 lb. pressure.

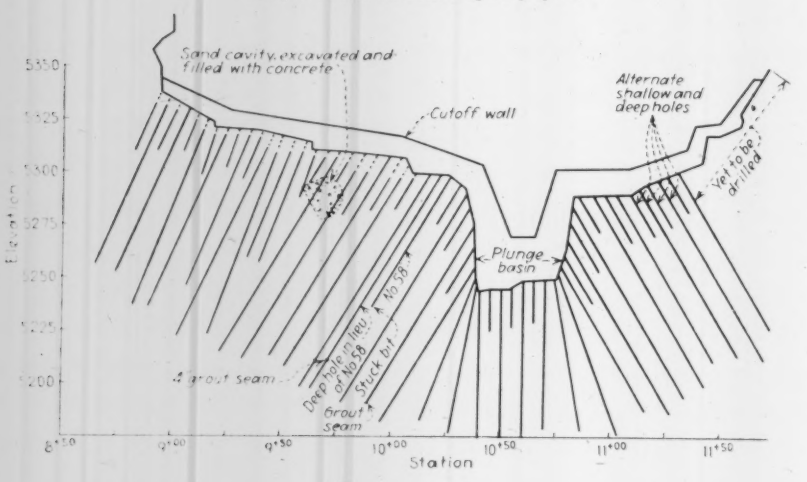
Drilling was carried out with two-cylinder air motors mounted on tripods. They averaged 10 ft. of 2-in. holes per hour per drill with maximums of 17½ ft. An 8-hr. shift often produced 120 ft. A start was made 2 to 3 ft. deep with 3-in. holes into which black iron pipes were caulked or grouted. Then 20 to 30 ft. of 2-in. hole was drilled for shallow grouting. Deep holes for 150 to 200 lb. pressures were then drilled.

Grouting was done with double-acting piston pumps to give continuous pressures without likelihood of entrapping air. Up to July 1, 201,240 cu.ft. of grout had been forced into 775 holes aggregating 50,010 ft. The aggregate footages


Rim grouting
C.L. intermediate cutoff wall
C.L. lower cutoff wall
Holes in sides of tunnel
C.L. upper cutoff wall
1-pump cap 2,000 g.p.m.
Main flow 80° to 100°
Toe of slope
NORTH PLATTE RIVER
Contractors emergency retaining wall
1-pump cap 2,000 g.p.m. (choked down to approx. ¼ capacity)
Drainage tunnel
Rim grouting
Holes drilled in tunnel face to grout off large flow of hot water
Holes in sides of tunnel
Approximate rock line below river bed
Rock surface
Low water El. 5330
Tensleep sandstone
All holes in section A-A (except No. 22 & No. 74) inclined 10° upstream, and 30° into canyon wall
Section B-B
Approx. contact
Section A-A
Amsden limestone
Tensleep sandstone
All holes in section A'-A' (except No. 81) and section C-C (except No. 58) are parallel to dam axis and inclined 30° into canyon wall
Approx. contact
Section C-C
Section A'-A'
Amsden limestone
Approximate rock line below river bed (from accompanying drill notes)

GROUTING as it was finally done consisted of a "rim" at the base of the canyon walls and across the upstream toe, curtain walls under the cutoff walls, "shell" grouting over whole area and concentrations where leakage and seams disclosed greatest accumulations of water.

GROUT CURTAIN under the upper cutoff wall through the plunge basin and sand cavity. This is the record up to July 15.



of the various depths of the holes are as follows: 150 to 200 ft. deep, 4,700 ft.; 100 to 150 ft., 19,100; 50 to 100 ft., 21,086; 25 to 50 ft. deep, 29,976 ft. and less than 25 ft., 1,254 ft. To these must be added 894 ft. of wash borings.

Nearly one third of the total amount of grout used was forced into two holes. The greatest amount, 38,061 cu.ft. went into a 1⅞-in. exploratory hole, accidently opened on May 1 after stripping was done. A rod was driven into it for anchorage and water spurted out under 20-lb. pressure. It had been driven 100 ft. deep in the central portion of the dam near the upstream curtain wall. The second largest consumer of grout was a hole 71 ft. deep located on the south side near the upstream cross curtain wall. It required 27,164 cu.ft. of grout and was a regular 2-in. hole. A third hole, 152 ft. deep on the south side near the intermediate cutoff wall, required 16,313 cu.ft. Several others required 10,000 to 12,000 cu.ft. For these large quantities where a thick grout was essential the mixture consisted of 4 parts dune sand from a bank found near the toe of the dam, 2 parts cement and 3.2 parts of water. For holes taking a relatively small amount of grout no sand was used but all gradations up to 4 parts of sand were used for the varying conditions.

Earth embankment

Starting May 25, 25,000 yd. of earth embankment had been placed by July 1, bringing the dam up to an average elevation of 5,294 which is about 50 ft. above the lowest place in the canyon floor. As the work progressed more rapidly and the fill widened, more rolling with sheepsfoot rollers and less hand tamping with pneumatic tampers was possible. The filling material is graded in the borrow pit and moisture is added there as required to give maximum compaction. From the pit it is hauled to the dam by 7-yd. dump trucks, spread by bulldozers to give 6-in. layers when compacted, and compacted by tampers and rollers. The latter are used wherever space permits but in the bottom and sides of the plunge basin, along canyon sides and near the cutoff walls hand tamping only is possible.

At the upstream toe and below the drainage gallery at the downstream portion of the stripped rock are gravel drains leading to centrifugal pumps that discharge into 10-in. rubber and steel pipe lines laid over the upstream cofferdam.

The material comes from a carefully sampled pit covering 50 acres of flood plane of the river downstream about a mile. The top, 3 to 6 ft. is topsoil with 80 per cent passing a 200 mesh sieve. A uniformly graded gravel layer, 10 ft. or more in depth, lies below the top soil and the inspector simply gives the shovel operator the depth of face to maintain to get the proper proportions. A 35 to 65 per cent proportion usually gives the required mixture. A dry density of 130 to 133 lb. per cu.ft. is usually attained. The surface of the borrow area is irrigated to about 9 per cent moisture by ponding ahead of excavation. When necessary a man applies the hose as the shovel operator proceeds. Some further sprinkling is required after the material has been placed in the embankment. To mix the soil and gravel prior to loading into the trucks, the operator pushes the shovel with gate open upward through the face.

A compaction from twelve passes with a standard sheepsfoot roller is called for in the specifications. Payment is made for more passes at the rate of 0.15 cents per cubic yard for each passage in excess of twelve. Likewise a reduction is made if less than twelve passes are found to be enough. Every step is under laboratory control and skilled inspection personnel has full charge of this portion of the work.

Three main reinforced concrete cutoff walls extend across the canyon floor and up the abutments. They are 12 in. thick

on top and have a ¼ to 12 batter. In addition to the three main walls there are two intermediate walls over especially leaky areas or where the abutments overhang. During construction, sections of the wall have been left out to provide passageways. The walls are waterproofed with an asphaltic paint.

TWO 2,000-G.P.M. PUMPS suspended from cables spanning canyon removed drainage water.

The main drainage feature is the inspection and drainage gallery located near the downstream toe of the most compacted impervious layer. It is egg shaped in cross section, 5 ft. wide and 7 ft. high, made sufficiently large for men to work in should further drilling and grouting be found necessary after the reservoir has been filled. After all grouting is complete, deep drainage holes from this gallery will be drilled on 10-ft. centers. As shown in one of the accompanying photographs, gravel is placed on the downstream side outside of the gallery. The backfill on the upstream side is impervious clay tamped against the gallery wall.

Some 200 ft. of this gallery was built in the open, the remainder being driven into the abutment sidewalls through the sandstone formation. In addition to the grouted curtain under the gallery the whole perimeter was drilled 6 to 8 ft. deep and grouted.

Personnel—The Casper-Alcova Project is being constructed by the U. S. Reclamation Bureau under the supervision of H. W. Bashore, construction engineer. I. J. Matthews is office engineer and resident engineer in charge of canals. John A. Beemer is resident engineer in charge of the Alcova Dam and J. H. Warner is resident engineer in charge of the Seminoe Dam. W. E. Callahan Construction Co. and Gunther & Shirley are the general contractors for Alcova Dam with George W. Condon Co. subcontractor for the earth work, and the Continental Drilling Co., subcontractor for the drilling. The general contractor did the grouting. W. E. Callahan Construction Co. and Gunther & Shirley are also the contractors for four tunnels on the canal, with a combined length of 10,000 ft. Winston Bros. Co., The Utah Construction Co., and Morrison-Knudsen Co., Inc., are general contractors for the Seminoe dam, a concrete gravity dam now in the preliminary stages of construction.

A Formula for the Adjustment Of Current Velocity Meters

OTTO RACKER
Brooklyn, N. Y.

IT IS generally assumed that electric velocity meters used in measuring discharges are accurate to about 3 per cent. This is only true if the amount of friction in the bearing of the vertical spindle is the same as it was at the time the rating table of the meter was constructed. This amount of friction does not remain constant; and, with a change in the coefficient of friction, the reading of the meter may vary considerably. The writer has obtained results varying by as much as 12 per cent from two instruments of the same type and manufacture, apparently in good working condition, and having identical rating tables. It was found that to obtain accurate readings it was necessary to adjust the instrument periodically by setting the spindle at the same friction as it had originally.

Comparison Between Computed and Observed Time Intervals

Trial	Time for five turns	Time for ten turns	Time for ten turns (computed)
1	3.2	8.4	8.7
2	7.2	24.6	24.7
3	2.2	6.4	6.5
4	4.2	9.2	9.8
5	4.8	11.4	12.6

A formula for making such adjustments was derived as follows:

Let it be assumed that, within the range of velocities considered, the retarding force of friction, r, is directly proportional to the velocity. Then we have

$$r = k_1 v \qquad \text{Eq. (1)}$$

Moreover, since acceleration is proportional to force, we have,

$$k_2 r = \alpha = \frac{dv}{dt} \qquad \text{Eq. (2)}$$

Substituting from Eq. (2) into Eq. (1), and coalescing the constants,

$$\frac{dv}{dt} = kv$$

Integrating,

$$\log v = kt + c_1$$

whence,

$$v = c_2 e^{kt} \qquad \text{Eq. (3)}$$

but, if s equals the distance traveled, we have,

$$v = \frac{ds}{dt}$$

Substituting this value into Eq. (3), integrating, and coalescing constants,

$$s = ce^{kt} + c' \qquad \text{Eq. (4)}$$

When t equals 0, s equals 0. Hence,

$$c' = -c$$

and Eq. (4) becomes

$$s = c(e^{kt} - 1) \qquad \text{Eq. (5)}$$

Now, if t_5 is the time required for five turns of the instrument, and t_{10} for ten turns, we have, from Eq. (5), since

$$s_{10} = s_5$$

$$e^{kt_{10}} = 2e^{kt_5} - 1$$

whence, taking logarithms to base ten of both sides of the equation, and solving,

$$t_{10} = \frac{\log (2e^{kt_5} - 1)}{k \log e}$$

From this equation the time required for ten revolutions of the instrument can be calculated for any given value of the time required for five revolutions, with a known value of the friction coefficient, k. Or the friction coefficient can be calculated for observed values of the times.

Experiments were made on a meter to check the formula. The wheel of the instrument was spun by hand, and the time required for the first five and the first ten revolutions measured with a stop watch. The results of five trials are shown in the accompanying table. The right hand column shows the computed time for ten revolutions, using a mean value of the constant. It will be seen that there is a good agreement.

It would be desirable for the user of a velocity meter to obtain from the maker the value of the constant, k, at the time the rating table of the instrument was constructed.

Before using the instrument, the engineer should check the friction by observing the time for five and ten revolutions for one trial. Then the value of the constant can be determined from the formula. Should the value of k so obtained differ from the original value, the friction must be adjusted by loosening or tightening the bearing of the spindle.

FIG 1—NEW TYPE continuous truss bridge over the Monongahela River between Pittsburgh and Homestead which is statically determinant by virtue of pin jointed rhomboid panels over the intermediate piers. The four span main river bridge comprises one continuous group, while the six spans of trusses in the Homestead approach comprise the second group. Eighth Ave. in Homestead is at the left.

Continuity and Determinacy Combined in New Bridge

Monongahela River crossing between Pittsburgh and Homestead utilizes Wichert trusses in which the panel of members over the piers is a pin-jointed rhomboid instead of the more usual triangle

A UNIQUE TYPE of continuous truss bridge is under construction over the Monongahela River 8 miles above its mouth in downtown Pittsburgh. Having all the advantages of continuity, such as rigidity, economy of material, and smaller foundations, the trusses of the bridge are at the same time statically determinate. As a result, the truss has the special advantage for a continuous structure of ease and directness of analysis and certainty of reactions. Known as the Wichert truss, a name taken from the man who developed it, this special type of structure boasts other claimed advantages—the moment distribution may be accurately controlled, the stresses are unaffected by temperature differences between the chords and are negligibly affected by pier settlement, and the reactions do not need to be adjusted as they do in most continuous structures. These special qualities result solely from the expedient of arranging the panel of members over the intermediate piers in the form of a rhomboid pinned at the corners and oriented so that one corner rests on the pier.

The Homestead Bridge has been designed and is being built under the supervision of the engineers of the Allegheny County Authority with a PWA loan and grant. It is a high level structure in contrast to the nearby Brown's Bridge which it replaces. The old bridge, of simple through truss design, was built in 1894 and its approach roads on both sides of the river have long been a source of trouble and delay to traffic.

As shown in Fig. 1 the new bridge is a long deck structure extending some 3200 ft. from near the top of a bluff on the Pittsburgh side across the river to a junction in Homestead with 8th Ave., a main thoroughfare along the edge of the business district. Two groups of Wichert truss units are included in this length. The main river crossing consists of a four span unit (291-533½-533½-291 ft.) with curved lower chords. (As the bridge is viewed in Fig. 1, these spans are designated as Number 17, 16, 15 and 14 from the right or Pittsburgh abutment to the left.) Adjoining this unit in the Homestead approach is a six span group with 128 ft. end spans and 163 ft. intermediate spans, all with parallel chords. The shoes of the main truss spans rest on sandstone faced concrete piers and abutments, those of the approaches on steel bents. The support between the main and approach spans is also a heavy steel bent resting on a concrete base on piles.

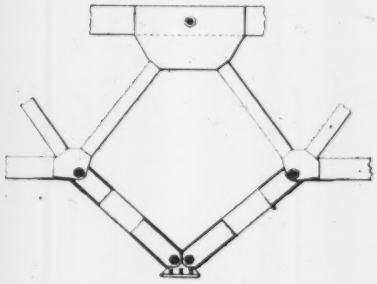


FIG. 2—TYPICAL RHOMBOID PANEL of a Wichert truss.

The remainder of the length is made up of six plate girder spans over the tracks of the Pennsylvania and Pittsburgh & Lake Erie railroads and a 65-ft. steel rigid frame over 7th Ave. A grade of 3.5 per cent was necessary over the first 2½ spans in order to cross 7th Ave. without requiring it to be depressed more than 3½ ft. This grade is followed by a 218 ft. parabolic curve over the railroad tracks. A break in grade to 0.5 per cent is then made, to keep the structure as low as possible at the point where the 5th Ave. ramp connects in the first truss span. A 240 ft. parabolic curve then gives transition to the 3 per cent grade that is used on the balance of the structure.

The bridge carries a 40-ft. roadway and two 8-ft. cantilevered sidewalks. The girders in the first five spans are 44 ft. center to center as a result of the through girders required in span 5 to maintain the minimum clearance over the P.R.R. tracks. On the remainder of the bridge the girders and trusses are 40 ft. on centers.

The roadway pavement is a concrete filled steel I-grid, about 4¼ in. deep with a maximum weight of 60 lb. per sq.ft. Sidewalk slabs are made of burned clay aggregate concrete with a unit weight of 100 lb. per cu.ft.

The bridge was designed for a live load on each truss consisting of one lane of trucks, one lane of street cars, and a 6 ft. width of loading on the sidewalk, giving 1.13 kips per lin.ft. for uniform load (moment and shear) and 115 kips for moment and 128 kips for shear under concentrated loads. In no case did the specified combination that included wind stresses govern the design of the trusses and they therefore were omitted.

Design considerations

In the analysis of the Wichert truss, the moment about the upper hinge point of the rhomboid is a controlling factor. This moment, resisted by the thrust of the rhomboid struts, is determined by the product of the reaction at the pier times a constant that reflects the dimensions of the rhomboid. As a consequence, the reactions are obtained simply by taking moments about the upper

hinge points and solving the several equations simultaneously. The rhomboid constant is expressed in feet. Its value is one-half the base of a right triangle whose altitude is a line joining the upper and lower hinge points and whose hypotenuse is one of the rhomboid struts extended to an intersection with a horizontal line drawn through the upper hinge point.

As in other continuous trusses, the so-called "fixed points" are of prime importance and form the basis of all analyses connected with the truss. These points, whose positions are fixed by the dimensions of the truss and are independent of the loading, are two in number in each span, one near the left end and one near the right end.

Once the fixed points are determined, all influence lines are readily determined; the influence line for the end reaction may in fact be drawn by inspection. The influence lines consist of straight lines, those for the reactions connecting the upper hinge points of the rhomboids. Since the lines are based solely upon the dimensions of the truss, stresses obtained from them are final and do not have to be corrected for factors which depend upon the sections chosen for the members.

Since the dimensions of the rhomboid and consequently the rhomboid constant may be varied at will, the moment distribution is thus under control, permitting the truss outline to be varied to suit requirements of economics or esthetics. For purposes of economy, the dead load moment curve is made to correspond as closely as practicable to the truss outline. This moment curve is obtained by sketching the simple span bending moment and then adding a closing line that gives the proper value for the negative moments over the piers. These latter moments are of course obtained from the reactions and the rhomboid constants.

The rhomboid constants at piers 15 and 17 are 47.8641 ft. and at pier 16 (in the center of the river) 54.6887 ft. Using these values the dead load moment at these three piers was selected so as to give the most economical distribution. This required a higher moment at the center pier than at the two others.

Although a complete examination of secondary stresses in the trusses of the Homestead bridge was not made, the maximum secondary stress found for the several conditions of loading investigated was about 20 per cent of the primary stress. Low secondary stresses are a particular advantage claimed for the Wichert truss over a cantilever or a conventional continuous truss although the designers of the Homestead bridge believe that low secondaries are a minor consideration in the comparative economy of the Wichert truss. Friction in the joints of the rhomboid affect the secondary stresses in the adjacent members and for this reason extra precautions were taken to reduce this friction to a minimum, principally by using the smallest possible pins.

Details of one of the rhomboid panels in the four span main river group of trusses are shown in Fig. 3. The shoe is typical of that at piers 15 and 17; at pier 16 a fixed shoe is used. It will be noted that two pins are used in the shoe. Such an arrangement was chosen as giving a more simple detail than a single large pin. Also the two small pins were estimated to cause less friction than a single large pin.

Another element of the rhomboid make-up, chosen to reduce the size of the pins and therefore pin friction, is the forged billet bearing at the pins. Although the members are 30 in. deep, only 8 in. diameter pins are required. These billets are attached to the members by four 1-in. diameter tap bolts and by welds of both the plug and fillet type. Extra care is used to prevent corrosion or rusting in the vicinity of the pins; the lower ends of the rhomboid struts are filled with concrete and all openings where water might enter are sealed with asphalt cement.

In addition to the rhomboid panels, the trusses have other structural features. The top chords are utilized as stringers. No lacing bars are used on any member in the bridge; rolled sections are utilized wherever possible. Otherwise built-up sections with cover plates are used; from the lower cover plates of these members manholes, 12x18 in. at the joints and 10x18 in. elsewhere are cut at intervals of 3 ft. as an aid to riveting, inspection and painting. The diagonal and vertical members in the trusses are generally 27 in. wide flange beams.

The floor steel consists of 60-in. plate girders spanning between the trusses and two lines of 30-in. 116-lb. stringers placed 6 ft. either side of the bridge centerline. In addition the top chords of the trusses serve as stringers, as mentioned above. The stringer span is 24 ft. 3 in. In each such span length there are four lines of 21-in. cross beams framed into the chords and resting on the stringers.

The rhomboid struts are the heaviest bottom chord members in the bridge, carrying a load (dead plus live) of 3,113 kips. This is resisted by an effective section of 154.81 sq.in. The center panels of the top chords carry a load of 3,014 kips. All main bridge steel is copper-bearing. Of the 2,800 tons of steel in the trusses of the main river crossing, 2,400 are silicon steel and 400 carbon steel. Most of the steel in the approaches is copper-bearing, carbon steel. All rivets in the truss joints are 1⅛ in. in diameter, the shop rivets being of copper bearing carbon steel, and the field rivets of copper bearing manganese steel.

In so far as its continuous truss features are concerned, the 6-span group in the Homstead approach is similar to the main river crossing. The shorter spans, however, permit the use of a single-pin shoe. The principal other point of in-

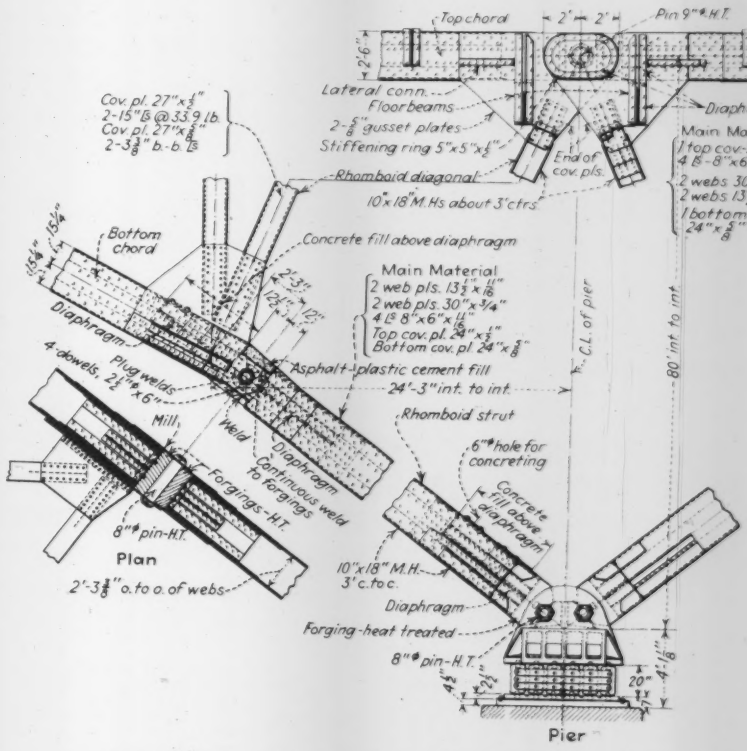


FIG. 3—RHOMBOID panel details at the two shore piers of the new Monongahela River crossing at Homestead, Pa. Details at center river pier same except for use of a fixed shoe which is similar but deeper because of the absence of rockers.

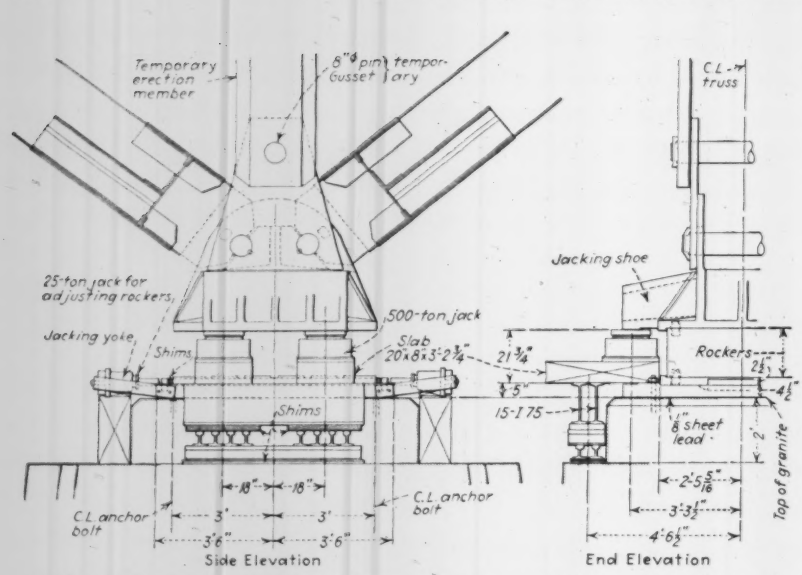


FIG. 5—JACKING details required at expansion shoes on piers 15 and 17 during erection.

terest lies in the method used to take care of expansion and longitudinal forces.

These spans, as shown in Fig. 1, are supported on steel portal braced bents. Beginning at the river end, the first three bents are slender two-column assemblies braced together by a truss near the top. The next two bents are of A-frame construction and relatively shorter.

All longitudinal forces are taken by the A-frame bent at pier 10. This bent is ony about 17 ft. high and has a base width of some 10 ft. The truss is attached to it by a fixed shoe. On the other A-frame bent a rocker bearing is used. Fixed shoes are also used on the two-column bents whose slender columns are designed to flex under longitudinal loads.

Steel erection began at pier 15 (on the left river bank in Fig. 1) with span 14 being erected on falsework with a crane working from the ground. After a few panels had been erected on span 14, a traveler working on the deck proceeded with the erection of spans 15, 16 and 17 in order. Two bents of falsework will be required for each main span. When span 15 is landed on the first bent, the bridge will be converted to a two-span Wichert truss and the next few panels cantilevered out from the bent. When this span has been landed on the second bent, the first bent will be removed and again the bridge will be, temporarily, a two-span Wichert layout. The erection will proceed in this manner until the north abutment is reached, no falsework being required for span 17.

In certain stages of the erection, temporary adjustable verticals will be used in the rhomboids for stability of the structure and for lowering the successive spans onto the bents.

Administration

The personnel of the Allegheny County Authority consists of J. F. Laboon, chairman; Henry Hornbostel, vice chairman; Park H. Martin, secretary, and Harry T. Aufderheide, treasurer. When the work was begun the chairman was Press C. Dowler who was succeeded by Samuel Eckels and the vice chairman and chief engineer was E. N. Hunting who was succeeded by John M. Rice. William McK. Reed was secretary-treasurer. George S. Richardson is bridge engineer.

The authority has retained since the beginning an advisory board of consulting engineers, consisting of J. E. Greiner and H. H. Allen, of the J. E. Greiner Co.; W. J. Douglas of Parsons, Klapp, Brinckerhoff & Douglas; Shortridge Hardesty of Waddel & Hardesty, and two local members, Robert A. Cummings and E. K. Morse.

The substructure contract for the Pittsburgh - Homestead Bridge was awarded last fall to the Holmes Construction Co., Wooster, Ohio, for $308,017. This work was completed on July 20. The erection of the superstructure by the American Bridge Co. which was awarded the contract for $1,080,802 was begun on July 6.

Primary Treatment and Incineration For Detroit's New Sewage Plant

IN CONNECTION with the Detroit, Mich. sewage treatment program certain basic plans have been decided upon by the engineers and are reported by L. G. Lenhardt, commissioner of public works, as follows:

The degree of purification has been fixed at 55 per cent removal of total suspended solids by the treatment works which are to consist of grit chambers, primary settling tanks with chemical precipitation provisions and chlorination equipment. Sludge will be digested and then dewatered on vacuum filters; sludge gas will be used only for heating the tanks. Incinerators are to burn the 427 tons estimated daily production of sludge cake which will have a moisture content of 70 per cent when it leaves the filters.

Of the 96 acres of site provided 26 acres will now be covered by plant which is designed to treat the wastes from a population of 2,400,000 anticipated in 1950. Six pumps lifting the sewage 26 ft. will have capacities as follows: two at 200 sec.-ft.; two at 250 sec.-ft. and two at 300 sec.-ft. Provision will be made to install additional pumps at a later date.

The grit chambers, eight in number, are to be 150 ft. long, 15 ft. deep and of an average width of 16 ft. The eight primary settling tanks will be either of the circular type, 200 ft. in diameter, or rectangular chambers 270 ft. long by 120 ft. wide with the width divided into seven 16 ft. compartments. Eight vacuum filters, each 11½ ft. in diameter and 14 ft. long will be used.

Interceptors collecting the 58.5 m.g.d. of sewage from 140 sq. miles of drainage area will have a total length of 14 miles when complete of which 10 miles is new work. The diameters range from 9 to 16 ft. and the depth below Detroit River level is 20 ft. at average water surface in the interceptors. Velocity for average flow at the plant is 6.2 ft. per second which is accomplished by gradients of 0.032 to 0.047 ft. per 100 ft. Forty regulating chambers will be installed.

Discharge of effluent is in the Detroit River through an 18-ft. outfall 5,780 ft. long.

The work of both plant and sewers is being carried out with a $20,000,000 PWA loan and grant under the general direction of L. G. Lenhardt, commissioner of public works. J. S. Stringham, city engineer is in direct charge with Harrison P. Eddy, John H. Gregory and Clarence W. Hubbell as consulting engineers.

Upper Rio Grande Problem Under Study

Water resources, present uses and possible transmountain diversions are being investigated to lay the foundation for an interstate compact on water

OUR RAPIDLY DWINDLING SURPLUS of water resources is raising serious questions in many parts of the country. In the arid west certain of these questions are of critical importance, notably in the Utah basin and along the upper course of the Rio Grande. Their solution presents the most urgent problem of western development today.

Three states, from the Colorado park regions to the Mexican border, are involved in the shortage of water and the claims of different areas in the upper Rio Grande valley; international water questions and the treaty obligations of the United States further complicate the problem. To replace unrestrained competitive race for water appropriation, an exhaustive factual determination of supply and use requirements has been set in motion, preliminary to a joint federal and interstate agreement on water use. Its success promises to mean peaceful development and enjoyment of the stream resources throughout the large region from the San Luis valley to El Paso.
—EDITOR.

IN AN ATTEMPT to put an end to long-continued controversy between Colorado, New Mexico and Texas over the equitable division of the waters of the upper Rio Grande (above Fort Quitman, Tex.), an engineering investigation of the water resources and needs of the area is now in progress by cooperative action between the three states, various federal bureaus, and the National Resources Committee. It is known as the Rio Grande Joint Investigation. Before this work was decided upon, commissioners of the three states and a commissioner representing the federal government concluded, in 1929, the Rio Grande Compact, which was approved by the legislatures of the three states and by Congress. This compact provided that none of the three states will increase its use or make further depletions of the waters of the Rio Grande during the period of the compact. The original expiration date of the compact was June 1, 1935; this has been extended for two years. The present investigation will, it is hoped, form the basis for a permanent compact.

The federal government is vitally concerned in the upper Rio Grande basin not only because of its investment in Elephant Butte reservoir and the Rio Grande reclamation project but also because of the investment of Reconstruction Finance Corporation funds in the bonds of the Middle Rio Grande Conservancy District. Within the last two or three years federal funds have been sought for many public and private water projects in the basin. If, as has been contended, the available water resources are already fully appropriated, new projects would not only lead to conflicts but would damage the rights of thousands. Since life in the basin depends on water, readjustment in present uses of water and addition to the water supply from areas outside the basin are preferable to overdraft on the existing supply.

Appreciating this situation and spurred by the necessity for prompt action to stop the further uncoordinated development of water utilization projects, the National Resources Committee appointed a board to review the situation and recommended the best procedure. The President on Sept. 23, 1935, ordered that all projects proposed or applications made involving the expenditure of federal funds for the purpose of developing waters of the upper Rio Grande basin should receive the clearance of the National Resources Committee. A further result was the organization of the Rio Grande Joint Investigation.

As pointed out by the board of review, the outlook through many years for life in the upper Rio Grande basin is dark or bright depending fundamentally on the procedure followed in the immediate future with respect to its water problems. Two courses are open. On the one hand, the water users of the region may be left to seek protection for their investments through court adjudication; this is slow and unsatisfactory. On the other hand, a permanent compact can be framed under which the rights of the several states and their inhabitants in the waters of the valley would be established. This course, to which the National Resources Committee's cooperation with the states is directed, requires factual data and an inventory of water supplies and needs.

Last December the National Resources Committee held a conference with the three states and the Rio Grande Compact Commissioners at Santa Fe, at which it was agreed that a complete investigation of the water resources, uses and needs throughout the upper basin was the immediate and essential requirement. Subsequently Public Works Administration funds were allocated to this investigation on a contributory basis. In February complete plans for the Rio Grande Joint Investigation were agreed upon. The project must be completed within a year, and all field work must necessarily be completed in the 1936 season.

In general, the essential problem of the investigation is the determination for the upper Rio Grande basin and for each of the three major use areas (San Luis Valley, Middle Rio Grande Valley and Valley below Elephant Butte) of (1) water supply, (2) water needs or requirements, and (3) possibility of adding to the water supply by storage, importation (transmountain diversions), and salvage of present wastes and losses. This involves measurement of stream flow, of diversions and wastes and of consumptive use; mapping of vegetative cover; survey of reservoir and dam sites; study of transmountain diversion projects; and survey of underground water resources.

The organization of the Rio Grande Joint Investigation is headed by the National Resources Committee, which through its Water Resources Committee has appointed as a directing consulting committee Prof. Harlan H. Barrows, of the University of Chicago, and Prof. Frank Adams, of the University of California. Harlowe M. Stafford, formerly with the division of water resources of the California department of public works, is engineer in charge, with headquarters in the U. S. Court House at Santa Fe.

Most of the work has been assigned to three federal bureaus: the Water Resources Branch of the U. S. Geological Survey (measurement of streamflow and diversions, underground waters, and quality of water), Bureau of Agricultural Engineering (consumptive use, water requirements of irrigable lands), and Bureau of Reclamation (storage and importation possibilities, including four separate transmountain diversion projects from the San Juan tributary of the Colorado River). In addition the Soil Conservation Service, the Resettlement Administration and the Indian Service are cooperating, and numerous other federal, state and local agencies are giving assistance in services, records and office and laboratory space.

Self-Contained Community For Purdue Housing Clinic

Five modern low-cost houses completed for the housing research project are served by private water supply and sewerage systems

THE housing research project, sponsored jointly by industry and Purdue University, has progressed from an idea in the summer of 1935 to a community of five completed houses on a woodland site outside of West Lafayette, Ind. A private water supply and sewerage system have been installed, and in the near future the families of university professors will move into the houses, to wear them out in the interest of science and better cost accounting for the home owner. Already the exact first cost of the houses has been determined, by building by contract. When operation charges are determined, a complete record of what it costs to build and own a $5,000 house will be available for the first time.

In the terms of engineering, the project, as it now exists, is interesting in several particulars. The houses themselves are each of a different basic construction involving modern concepts and materials. Roads were built, sewers laid and a well water supply developed. The pump house of unique design is a striking example of low cost and attractive construction.

Design considerations

Each house was designed to accommodate a family consisting of two adults and two children, a boy and a girl. The specifications required the house to be erected under ordinary conditions, based on contractors' bids and without price concessions from materials dealers, at a cost not to exceed $5,000. Cheap construction has not been used, but in order to keep under the cost limit it has been necessary to eliminate some of the useful modern accessories. However, it was possible to use oil burners of the "flash" type in two of the houses and gas heat in one of the others.

Five houses finished

Brief descriptions of the five houses now completed indicate the several types of construction whose resistance to wear and weather will be studied. Three other houses are planned in the present program, to demonstrate the use of brick, reinforced brick and haydite blocks. Of the completed houses:

House No. 1, J. Andre Fouilhoux, architect, is a two-story frame house with walls, floors and flat roof of 2x4-in. studding an joists; studs are on 18 in. centers instead of the conventional 16 in. The exterior finish is cement stucco on paper-backed metal lath. All interior finish is ¼-in. plywood, painted. Mineral wool bats are used for insulation in the walls and under the roof. Total wall thickness is 4 in. The first floor is a 3-in. concrete slab placed on a sand-gravel fill, while the second floor is of wood. The first floor slab is covered with a 2-in. cold storage type insulation slab and ¾-in. hardwood blocks laid in mastic. Cost, $4,682.

House No. 2, Howard T. Fisher and John A. Pruyn, architects, is a General Houses, Inc. product and utilizes a steel frame with cement-asbestos sheet walls. The wall panels, about 1-in. thick, consist of an exterior sheet of asbestos-cement board, two air spaces separated by aluminum foil and ¼-in. plywood sheet on the interior. The roof panels consist of ¼-in. plywood sheets top and bottom and three air spaces formed by two sheets of aluminum foil. The roof panels are 2⅛ in thick. Interior partitions are about 1-in. thick and consist of plywood sheets both sides with felt paper between for sound deadening.

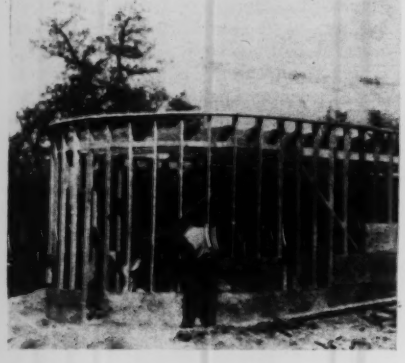
The house is one story high with a flat roof, the floor being a 4-in. concrete slab on a tamped cinder fill. The cost was $4,625.

House No. 3, Burnham Bros. & Hammond, Inc., architects, utilizes poured reinforced concrete walls and precast concrete joists with poured slab floors and roof deck. The concrete walls are 6 in. thick, covered on the inside with ¾ in. furring, ½ in. cane fiber insulation board and ½ in. of plaster. The roof and floors are framed with 8-in. precast joists covered with a 2½-in. poured concrete slab; on the roof, 1-in. cane fiber insulation board, and built-up asphalt roofing are utilized. Cost, $4,997.

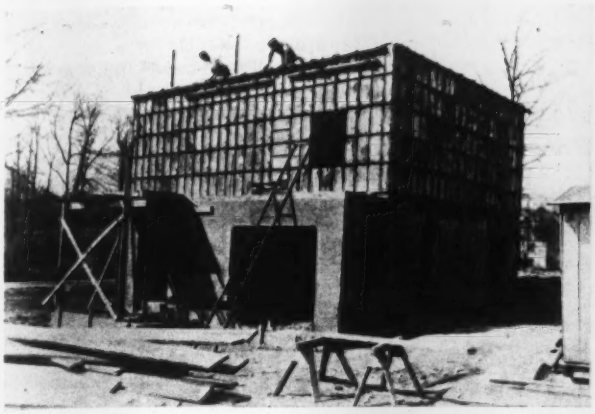
House No. 4, designed by the Insulated Steel Construction Co., is of the frameless steel type utilizing hollow sheet-steel panels for both the walls and the roof. Exterior and interior surfaces of the sheets are finished with a plastic paint. Insulation in the wall panels is mica chips. Total wall thickness is 3 in. The roof is covered with a 1-in. cane fiber insulation board and built-up asphalt roofing. The floor is of concrete on fill. Cost $4,992.

House No. 5, McNally & Quinn, is of conventional timber framing construction, two stories high with a sloping roof. Interior trim is plywood in white pine, fir, birch and gum. Insulation in both the walls and roof is mineral wool bats. The wall thickness including overlapping siding on the lower story is 5 in. Cost, $4,986.

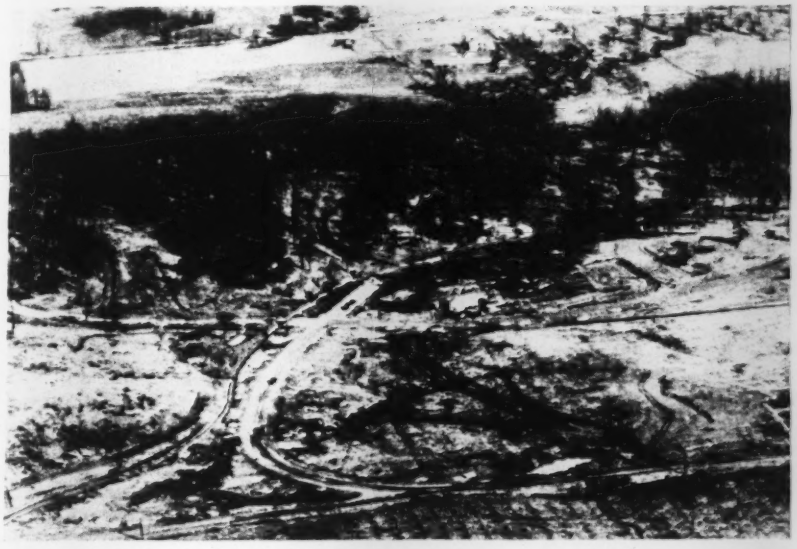
Since the site of the housing clinic village is over a half mile beyond the Purdue campus and the city limits, special provision had to be made for water supply and sewerage. Cost studies



CONSTRUCTION VIEWS of the water supply pump house showing, from left to right, installation of shredded wood slabs on the timber studs; application of stucco; and laying of shredded-wood roof slabs

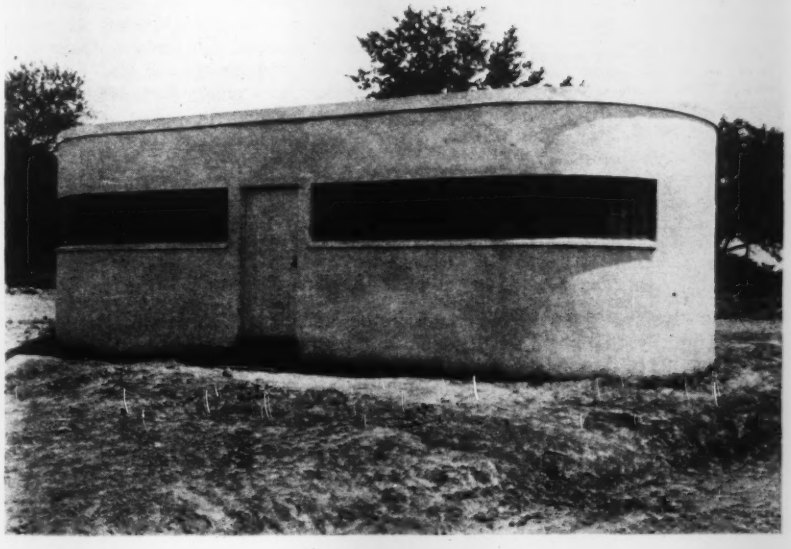


TWO OF THE NEW HOUSES. Left: pouring the second story of the concrete house. Right: erecting the steel panel house



ROLLING WOODLAND site of the Purdue housing research project

PUMP HOUSE of substantial and unique appearance, but economical in cost.



proved that it was more economical to build private facilities than to extend city lines to the site.

Sewage disposal is by means of a concrete septic tank installed at a low point, to permit gravity flow from all of the houses. The tank, equipped with a siphon overflow, is 12x12x38 ft. in principal dimensions and is designed to serve 150 persons. A 4,000-ft. effluent line of clay tile terminates in five branches that spread the discharge over a large natural gravel bed near the edge of the site. The sewer collection system is of 8 in. vitrified tile except where tree roots are numerous when spiral welded steel pipe is substituted.

Storm drainage is handled by 8-in. clay tile lines laid along either side of the roadways. The tile is laid with open joints, which were maintained open during backfilling by placing a piece of roofing felt over the top of the joint. The backfill is gravel. Culverts along the mile of new gravel roads are of semi-circular corrugated metal type resting on concrete abutments.

Water supply

The water system, installed at a cost less than that involved in bringing city water 3,000 ft. to the tract, includes a 230-ft. well, a pump, a 5,000 gal. pressure tank, a pump house, and 3-in. cast iron distribution lines laid with two-bolt machined joints. A 50-lb. pressure is carried. The pump has a capacity of 50 g.p.m. against a 300-ft. head. The pump bowls are at a depth of 180 ft.

No compressor is used to replace the air in the tank which is absorbed by the water. Instead, the pump is so arranged that all of the air in the well column is forced up into the supply tank ahead of the water when the pump starts. The tank is equipped with a pressure relief valve.

The water supply building, which houses central electrical and gas valves as well as the pumping equipment, is of attractive modern design with semi-circular ends and glass brick for windows. Designed by C. Paul Ulmer, resident

architect of the project, the building is of conventional wood framing but with a white stucco finish applied to an insulating base of shredded wood and refractory cement. It is estimated that the insulating value of this construction, in conjunction with the heat developed by the sporadic operation of the pump motor, will prevent freezing within the pump house during cold weather. The window sills are precast concrete units. The roof of shredded wood slabs is covered with built-up asphalt roofing.

The cost of this water supply system was as follows:

230 ft. well, at $2.25 per foot	$517.50
6 in. x 16 ft. screen	84.00
5,000 gal. storage tank, 72 in. x 24 ft.	369.32
Deep well turbine pump rated at 50 g.p.m. including 7½ hp. motor, pressure switch, drop pipe, etc.	1,048.27
Installation including connections	120.00
Water supply building	660.00
Total cost	$2,800.00

The research foundation which made this project possible was set up by David Ross, prominent Indiana industrialist and engineer and president of the board of trustees of Purdue University, who furnished the land which he transferred to the ownership of Purdue University. The individual houses are financed by the Purdue Research Foundation. Frank Watson is director of the work.

Demolition of Waterloo Bridge

Difficult task of taking down the stone arches without resort to underpinning completed and removal of piers now in progress.

A YEAR AGO contracts for the demolition of Waterloo Bridge over the Thames River at London, England, were let, thus bringing to an end ten years of controversy over what should be done with that world-renowned structure. The work of demolition now has progressed to the point where the arches all are down and the demolition of the piers is under way.

In a paper entitled "The Demolition of Waterloo Bridge," presented to the Institution of Civil Engineers, Ernest J. Buckton and Harry J. Fereday describe the involved work of demolition of the arches and make some observations on what has been revealed concerning the bridge by the demolition work.

Waterloo Bridge was built by a private company as a toll bridge in the period 1811 to 1817 from designs by John Rennie. It consisted of nine arches having elliptical soffits of 120 ft. clear span and 35 ft. rise, eight piers each 20 ft. thick, and two massive abutments. The roadway was 27 ft. 6 in. wide and there were two footways 7 ft. 6 in. each. The bridge proper was an unusually fine piece of stonework and because of its beauty and location has become world famous.

Early in the present century it became apparent that something soon must be done with the bridge—either it must be enlarged or replaced; settlement of two of the piers called for some major reconstruction work in any case.

Sentiment called for preservation of the structure but a careful engineering study showed that enlargement to meet modern requirements while still preserving the beauty of the original structure was out of the question, particularly in view of the settlement of part of the structure, and demolition was finally adopted as the proper procedure.

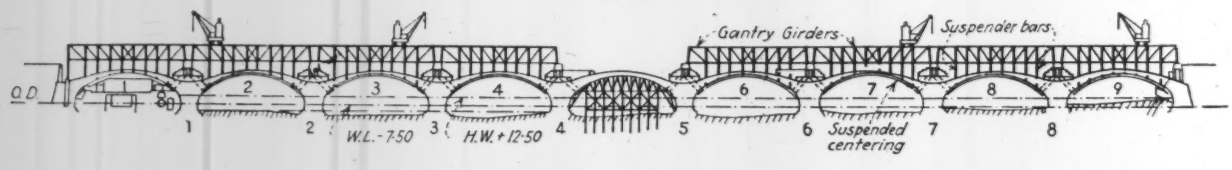
Some settlement of the bridge is reported to have occurred during construction, and progressive lowering of the water level due to channel changes made it necessary early in the life of the bridge to add protection around the piers to minimize the effect of wave action on the footings.

By 1882 further settlement had occurred and cracks had appeared in most piers, but all the arches were sound. Local movement at Pier 1 had been arrested by incorporating it in the Victoria embankment. The settlement continued to be more or less uniform until 1923 when there were indications of further movement which developed into serious local settlement of Piers 5 and 6. In 1924 the bridge was temporarily closed to traffic, the roadway was lightened locally to reduce the load on the foundations of those piers and arches 5 and 6 were propped from piles driven into the river bed. A temporary bridge of steel was constructed on the downstream side of the old bridge and opened in Septemebr, 1925.

Demolition was begun last year. Elaborate precautions were taken to carry forward the work in a manner calculated to prevent progressive collapse of the structure through the loss of arch action. The adopted scheme was to support each arch from a truss erected above the arch and supported on piers, and to support the haunch stones with anchors tied back into a reinforced concrete beam laid across the top of each pier.

"Actual removal of the arches themselves," the authors state, "was commenced by 'nibbling,' that is, taking away from all arches in succession a few voussoirs at the crown on both up and downstream sides. This was carried on until the 12-ft. strip was left in the center and the arch stones at the outer strip were racked back at about 45 deg. in plan from the arch keystone. The arches remained self-supporting. This was the condition causing maximum deviation of the 'line' arch from the arch axis, but the resulting calculated maximum stress was only about 50 per cent greater than the calculated maximum stress in the arch rings when the bridge was in service, and only a fraction of the safe compressive stress."

After this phase had been reached, the difficult task of transferring the load from the arches to the overhead girders was begun, the jacking being carried on progressively so that there would be no failure of suspender rods due to overload. Once the arch thrust had been offset the removal of the arch stones was begun, but the stones were kept stacked on the middle of the span so as to keep the overhead trusses de-



STEEL TRUSSES, supported on the piers of Waterloo Bridge, gradually took over the weight of the arches as the demolition progressed until all arch action had been relieved.

flected until the end courses were removed.

Commenting on the workmanship and materials, the authors state, "The workmanship was extremely good throughout. The perfection of the work in the exterior features, such as the balusters, coping, and cornice, has been apparent to all Londoners for a century, but it was only in the demolition of the bridge that it became known how perfectly every arch stone had been cut to taper and how solid and faultless had been the interior construction of the piers. There were practically no voids. The lime mortar in which the masonry was built was exceedingly good."

Since the publication of the paper by Buckton and Fereday, the demolition of the fifth and sixth piers, the two in which bad settlement occurred, has been completed, revealing the condition of the foundation. As reported in *The Engineer*, May 15, p. 524, the foundation of Pier 5 contained 220 piles, generally round in shape, from 13 to 19 ft. long and tapering from a thickness of 10 in. to 14 in. at the top to 7 to 10 in. at the bottom. Of the nine piles in each row, the two outer piles at each end were found to be inclined toward the center of the pier, and the five central piles were vertical. On top of the piles was a cross framework of timber filled with rubble stone and tightly fitted square blocks of stone supporting a plank platform upon which the masonry stood. The footings or projections of the lower courses of the masonry were unusually wide in proportion to their height and were found to be broken away from the body of the pier and the transverse timbers broken under the footings, while in some cases the piles appeared to have slipped from underneath them. Of the 220 piles, 130 were extracted whole with shoes still attached, but the remainder came out in short lengths from 5 to 15 ft. In nearly all cases it appeared that they had been broken for some time. The timber was elm, beech and fir.

The platforms generally were in poor condition but the larger supporting timbers were generally in good condition. The piles where well buried in the clay, were good, but deteriorated at the head.

The foundation arrangement at the sixth pier was similar to that of the fifth except that all the piles were about vertical, including the outer rows. Ninety per cent of these piles came out whole.

Commenting on the breaking off of the footings (which had been known for some time as the result of examinations of the settled piers), Buckton and Fereday state, "that Rennie realized later the defect in design of the footings as evidenced at London Bridge, designed by him and built between 1824 and 1831 under the supervision of his son. A similar spread of footings is there distributed in a height of 20 ft. instead of 6 ft. as at Waterloo Bridge."

Hydraulic Valve Operation Controlled by Small Motor-Driven Pumps

A system of hydro-electric valve control for a water filtration plant which eliminates complicated piping to the control table and assures positive operation

By Harold Vagtborg
Assistant Professor of Municipal and Sanitary Engineering, Armour Institute of Technology, Chicago

Hydraulically operated valves of the 15 m.g.d. municipal water softening plant put into operation last July at Shenandoah, Ia., are controlled by small reversible motors driving oil pumps located on the valves. Thus only electrical wiring is carried to the control table on the operating floor and the ordinary pressure pipe lines controlled by four-way cocks are eliminated. The operating table and the valves are connected only by a conduit carrying 110-volt wiring for the motor and 6-volt wiring for the position indicating system.

As first installed the system did not provide a means of compensating for the difference between the volume of oil on each side of the piston. Originally it did not appear that such compensation would be required but a study of the diagram (Fig. 1) shows the obvious necessity of absorbing the extra oil in the system when the piston moves upward and providing additional oil when the piston moves downward, due to the difference in displacement by the piston rod. Early trials without the compensating device were satisfactory when the valve was being closed until the oil below the piston was depleted. Additional oil, however, was not available to fill the valve chamber above the piston for completely closed position.

Compensating oil reservoir

The first consideration of a compensating device contemplated the use of a tail rod of the same size as the piston rod. To obviate the construction of special hydraulic cylinders a compensating reservoir was inserted in the pressure supply line with a regulating by-pass timer set to control the speed of opening or closing the valve.

To close or open the valve the motor is run forward or backward. Resistance in the valve position indicating circuit is varied as the contact arm changes position; limit switches are operated at the ends of the full open or closed valve movement.

Each set of filter and sedimentation influent valves is operated by one selector hand and one pair of start and stop pushbuttons. These pushbuttons on the control table and the limit switches in the resistance boxes at the valve being operated control the 6-volt relay, which in turn operates the 110-volt motor circuit. One galvanometer at the control table is used to indicate opening position of five valves. This is possible because only one valve is in circuit at one time. To enable the use of the single galvanometer the resistances of all five circuits are balanced by compensating resistors.

In preliminary tests, it was found that

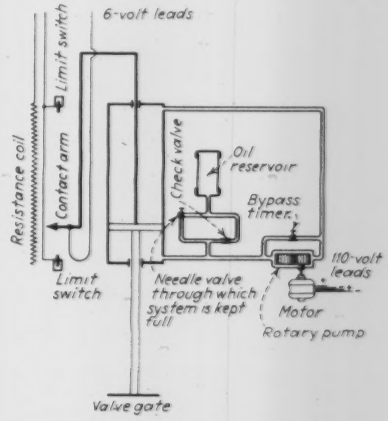
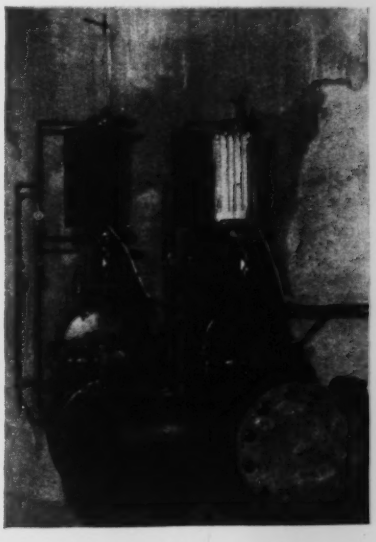


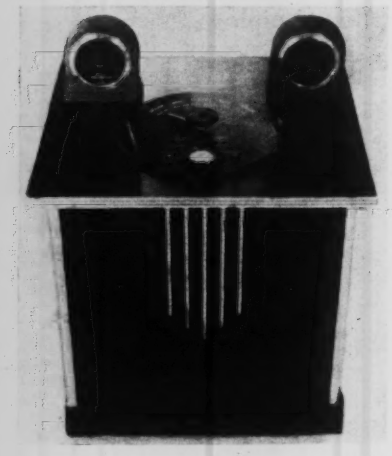
FIG. 1—OIL PIPING connectors and electrical hook-up for controlling valves.

FIG. 2—CONTROL UNITS mounted on the valves, showing the position of the motor-driven pumps and the limit switches attached to the oil piston.



the usual occasional sticking of hydraulic valves was eliminated because when such a condition arose, the pump would build up a sufficient pressure to break the seal. This is a definite advantage over the standard hydraulic valve operation where water pressure is usually limited. One valve gave particular difficulty in the early tests and at times, until rectified, required more than 100 lb. pressure in the piston chamber to break the seal.

FIG. 3—FILTER CONTROL TABLE with the electrical valve operating switch in the center. Rate of flow and loss of head in the filters are shown by the meters in the background.



The original installation provided for oil pumps of equal capacity. Because of the relatively larger diameter of the influent and drain valves, these pumps were later increased in size in order to speed up operation to a rate not obtainable by regulation of the bypass timer and the smaller pump. All preliminary tests were conducted prior to September 1, 1935, and since that no further adjustments have been required.

Water is supplied to the softening plant by four remote controlled wells, located from 1,800 to 5,000 ft. from the plant. Starting and stopping switches with indicating lights are located on the main switchboard at the plant. Lubrication of well pumping equipment is obtained by solenoid operated oil feeders which operate only when the pump motor circuit is closed.

Tests on Transferal of Stress Between Concrete and Steel

Twelve test specimens each develop enough bond to transmit working stress of steel from one lapped bar to another

By Paul Beermann
Assistant Engineer, San Diego, Calif.

IN PLANNING the placement of additional concrete for strengthening Hodge Reservoir multiple arch dam near San Diego, question arose as to how much thickness of concrete was necessary to transmit the tensile stress from bar to bar where steel reinforcing terminates in straight laps. A search of technical literature failed to reveal any basic information on this general subject. Hence, although complete investigation could not be undertaken, at the suggestion of the state engineer's office, a few specimens were made up and tested to destruction to get some confirmation of expected strength. Results of these tests gave assurance as to safety of assumptions made in this particular design.

The tests were made with ½-in. corrugated steel reinforcing rods embedded in a mixture of high-early-strength cement and sand. The proportions of the mix were one part of cement (by volume) to three parts of sand. The mix was rather dry. Each specimen had only one pair of bars and in each case the length of the lap was the full length of the specimen; that is, the lap was 20 in. in the 20-in. specimens and 28 in. in the 28-in. specimens.

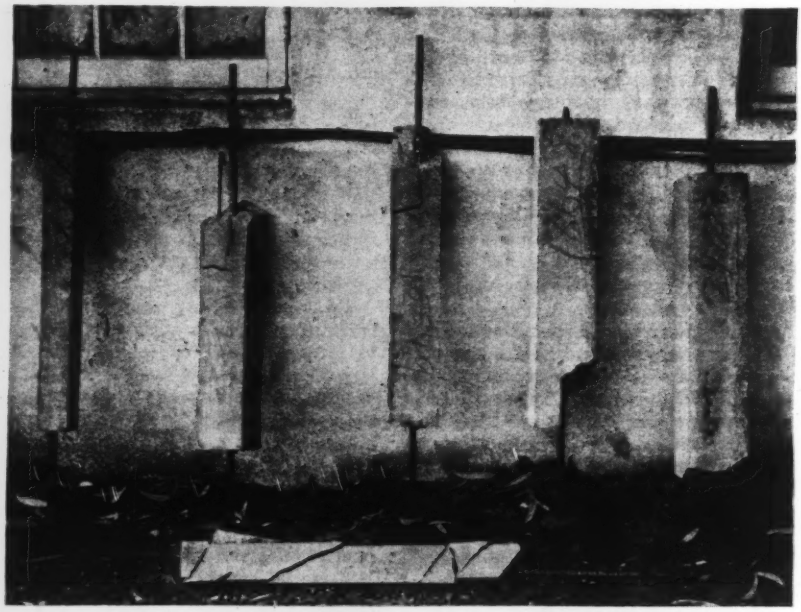
Ten days after the specimens were cast they were tested in tension to destruction. The earliest sign of failure usually occurred at the end of the specimen and appeared first in the form of spalling near the corrugations close to the ends of the specimens. Because of this spalling it was concluded that in a repetition of such tests it would be well to avoid this weakness by first grinding or filing off those corrugations that would be embedded in the specimen near its ends. The results of the twelve tests are given in the accompanying table.

TABLE 1—RESULTS OF TENSION TESTS ON ½-IN. BARS EMBEDDED IN CEMENT MORTAR

Number of Specimens Tested	Size of Specimen (In.)	Average Load When First Crack Appeared (lb.)	Average Load at Failure (lb.)	Average Unit Stress Developed in Steel (lb. per sq. in.)
2	3x3x20	8,250	11,800	47,198
2	4½x4½x20	12,500	15,675	62,698
2	5½x5½x20	13,000	15,513	62,054
2	3x3x28	11,200	13,523	54,094
2	4½x4½x28	9,650	15,905	63,618
2	5½x5½x28	12,100	21,324	85,296

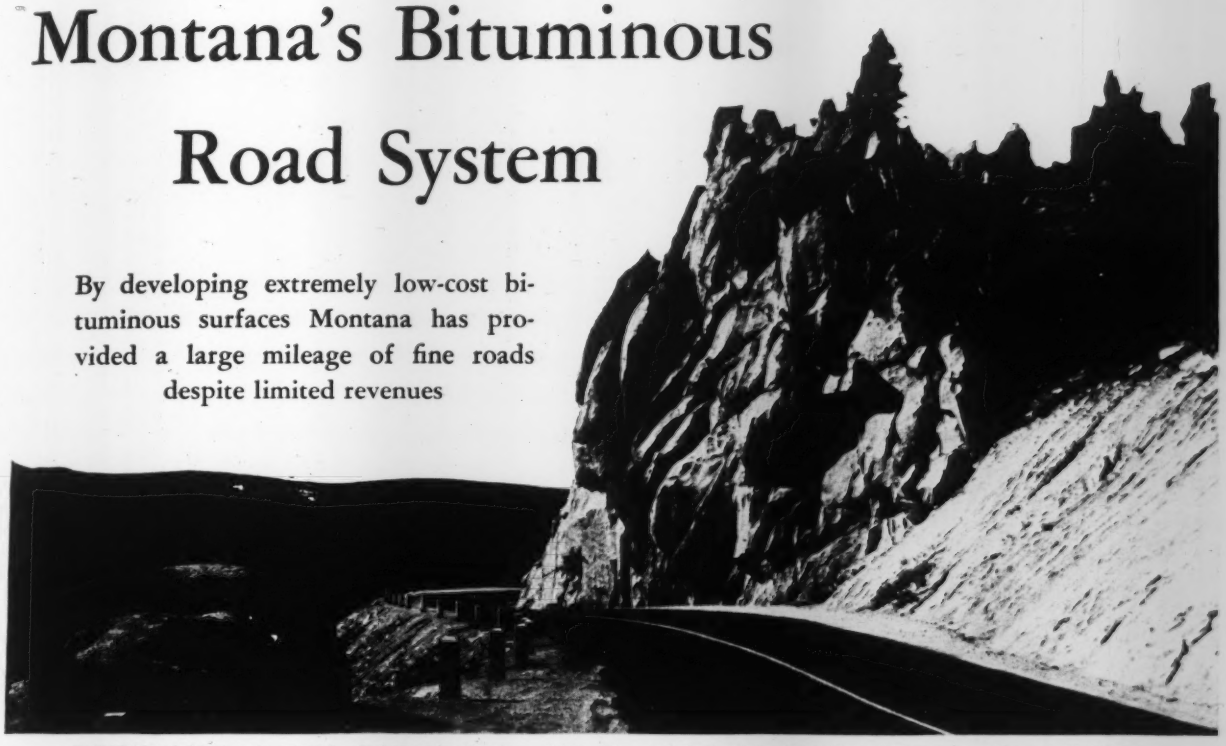
The author hopes that someone may be able to make a more complete and systematic investigation of this subject. Objectives suggested are the answers to several questions, namely: (1) How does the concrete function in transferring stress from one bar to another? (2) What is the minimum cross-sectional area of concrete at the lap necessary to transmit the full strength of the steel? (3) As compared to straight laps, what is the result if loops are used? (4) What is the effect of continuing the concrete in the test specimens beyond the lap?

FIG. 1—TEST SPECIMENS showing typical failure after bars were pulled in tension.



Montana's Bituminous Road System

By developing extremely low-cost bituminous surfaces Montana has provided a large mileage of fine roads despite limited revenues



TYPICAL of Montana's network of thousands of miles of bituminous roads is this mountain section between Butte and Helena.

FROM the badlands of the Missouri and Yellowstone Rivers in the east to the Rocky Mountains in the west, across barren prairies and shale bench lands, through mountain forests, valleys and passes, Montana has an excellent system of state highways. The state is truly the "wide open spaces," with only 3.7 persons for each of its 146,131 sq.mi. of area, a sparsity of population exceeded by only three other states. The distances are great—one through hard-surfaced route across the state is 786 miles long, equal to the rail distance between Chicago and Washington. Another paved route between Miles City and Jordan, stretches for 86 miles without passing a town. Though hampered by low revenues and faced with topographical and climatic difficulties known only to the West, the highway department has spread a network of 5,500 miles of adequate roads over the state, 4,600 miles of which will have a gravel or better surface by the end of this season.

The Montana state highway system has been developed on the theory that, with the limited funds available, it is best to spread the money as thin as possible and yet provide adequate, serviceable roads to all parts of the state. Consequently, by far and large, the state roads are of the low-type, bituminous surfacing which is improved as traffic warrants additional expenditure.

To meet the need of low-cost, yet satisfactory surfacing for great mileages, the highway engineers turned to bituminous road construction. They not only turned to this type of road, but they concentrated upon it exclusively, for today in the 4,000 miles of surfaced and surface-treated highways, there are only 40 miles of concrete slab, near Butte, and none of any other material. Through concentration upon bituminous surfacing, the department has developed a road-betterment program to high efficiency, with a type of treatment to serve every traffic requirement.

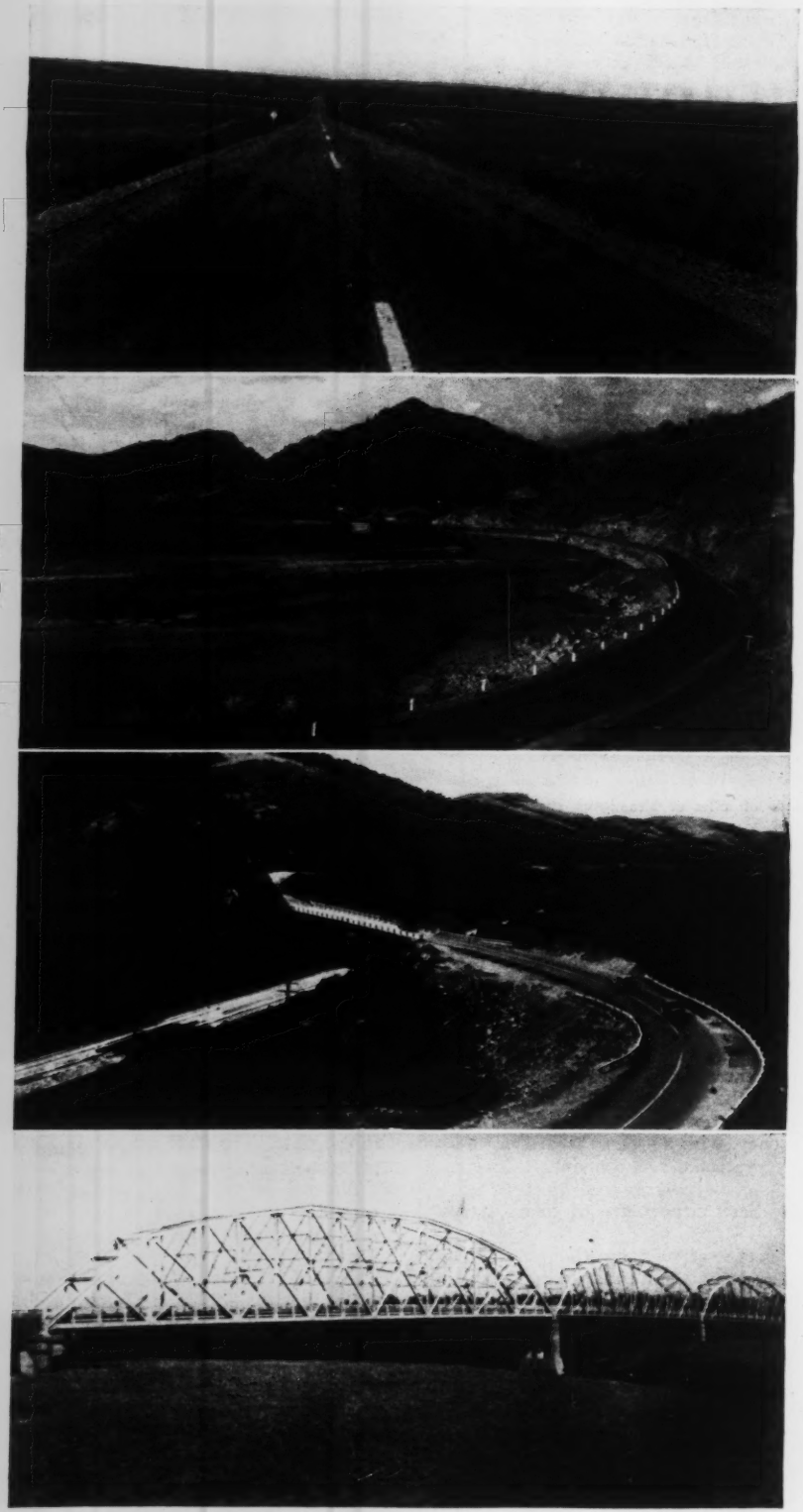
Seek experience of other states

Yet, satisfactory though the roads may be to the traveling public, the state highway engineers are not satisfied that they have reached perfection on the technique of bituminous construction. Believing that all of the western states would benefit by an exchange of views and experiences in their development of low-cost bituminous roads, Montana was host at a bituminous conference held at Butte last fall, at which the operating engineers presented a series of technical papers and participated in enlightening discussion. The conference was so successful that it is now scheduled as an annual affair. This year's meeting will be held in Glacier National Park next week, with an expected attendance of more than 500 delegates.

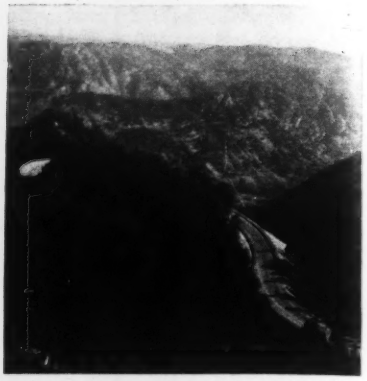
Except for federal aid, the sole revenue of the state highway department is the gasoline tax. Montana is one of the few states that does not tolerate diversion of gas tax money to purposes other than road-building, though about 20 per cent of the gross tax collected is refunded to farmers and other users of non-taxable gas in agricultural and non-vehicular equipment. After deduction of refunds, the gas tax varies from 3½ to 4 million dollars a year. There are about 150,000 motor vehicles registered in the state. The state gas tax is 5 cents per gal.

Normal federal aid, matched 44 per cent state funds against 56 per cent federal contribution, amounts to $2,500,000. Montana's share of the last federal emergency highway appropriation was 6½ millions. All of the motor vehicle fees, aggregating $1,000,000 yearly, goes to the counties for road purposes. About $90,000 per year, collected as drivers' license fees, goes to the sole support of the newly organized state highway patrol, now consisting of 30 patrolmen and 30 cars.

Annual maintenance expenditures amount to 1¾ millions, and another ¾ million dollars is put aside to retire an issue of highway debentures. Every remaining dollar goes to match federal aid appropriations. Montana was allotted $2,700,000 of the federal grade crossing elimination funds. This money is being spent on 25 structures, all completed or under contract at this time.



FOUR VIEWS of Montana highways and bridges. Beginning at the top—A thin-mat surface, costing $600 per mile, on prairie section of U. S. Route 2 near Bainville; Heaviest type of bituminous surface of thick plant-mix mat on Helena-Great Falls route at entrance to Missouri River canyon; Overpass at U. S. Route 10 crossing No. Pac. R.R. near Bozeman; Missouri River Bridge at Wolf Point, an example of the state's modern bridge construction.



A GLIMPSE of the Red Lodge-Cooke City scenic drive leading to the new northeastern entrance to Yellowstone Park.

Tourists encouraged

Tourist traffic is not only welcome in Montana—it is encouraged and cultivated. An investigation by the department reveals that tourists contributed 1½ millions of the gas tax collected last year. While traditional Western hospitality demands courtesy be extended to all visitors, the highway officials realize that the encouragement of tourist traffic means more than a mere friendly gesture, it means additional revenue for the department dependent solely upon gas taxes for its income.

Therefore, the highway department has assumed the role of official host to all vehicular tourist traffic and has developed an extensive program to lure visitors to the state and to make them welcome during their stay. The official highway map carries a cordial welcome by the governor; numerous attractive bulletins, well illustrated and written in a breezy Western style by a highway engineer, are widely distributed. Points of historical interest are marked by sign boards portraying a bit of legendary history of the locality, set in rustic frames on off-the-road parking areas. Road intersections are well marked with directional and mileage signs for the benefit of the stranger, and route signs giving the mileage to the next large town appear every 5 mi. between intersections.

At the opening of the current travel season, the highway department started a service that is proving highly popular with the visitor. At the terminal of nine main routes at the state boundaries, ports of entry stations have been established, at which all out-of-state cars are required to stop upon entering Montana. Each station is manned by three trained college students in uniform. Visitors are cordially welcomed to the state, given strip and general maps, folders, hotel and camp information and any other data requested. The attendants are also authorized to sell fishing and hunting licenses. It is interesting to note that the highway department has investigated every hotel and camp within the state, publishes their prices and frankly

WELCOME TO TOURISTS. At the left D. A. McKinnon, state highway engineer, is exhibiting the burnished sign of ¼-in. copper plate, cut on the state's outline, that welcomes the visitor at the Culbertson port of entry station. The station is shown at the right; the attendants had not yet received their attractive uniforms, with which the personnel of all nine ports are now equipped.

rates them into four classes of cleanliness and desirability. The customs stations on the Canadian border also serve the tourists in the same manner as do the domestic ports of entry. Each car driver is given a card to fill out and mail to the department, stating the number in the party, routes and mileages covered, amount spent within the state, etc. In the first three weeks over 10,000 cards were received at Helena headquarters.

The highway department is also conducting a safety campaign to reduce accidents. Dangerous places on the highways, impossible to remedy, are marked with ample warning signs. Large bulletin boards carrying brief safety messages are widely distributed. The effect of the campaign is noted in a reduction of 25 per cent in highway fatalities in 1935 over the previous year, and a further reduction of 10 per cent so far this year. The department has adopted as standard a laminated timber guard rail, built up of four 2x8-in. planks carried by heavy timber posts. The rail is practically indestructible, and usually deflects the vehicle back to the road without causing serious damage.

Road design and construction

Montana's present standard highway has a minimum grade width of 30 ft. and a 24-ft. surface. Obviously, many of the older roads are narrower than this standard, but they are being widened as rapidly as possible by maintenance forces. Except for this widening work and occasional penetration of an old road, all new and betterment construction is done by contract.

The highway engineers regard the foundation of the roads as all important. They stress the value of a good, sound base, and place as a wearing surface as thin a mat as will adequately carry the traffic. In brief, the highway program is to provide a foundation capable of carrying the heaviest traffic, then build up the surface as traffic warrants. Naturally, with such attention paid to the foundation, drainage is given careful consideration. There are plenty of culverts and other drainage structures installed, and the department is strong on shoulder maintenance to keep water off the edges of the road.

Grading on the standard road varies from 7,000 to 20,000 cu.yd. per mile, depending on the topography. In rough mountainous areas, the excavation occasionally runs higher.

Upon the subgrade is placed 5 in. of pit-run gravel, with stones above 3 in. in size screened out. Then a 2-in. layer of screened and crushed gravel or stone is spread over the lower course, providing a base of 7 in. minimum thickness. The base requires about 3,500 cu.yd. of material per mile, averaging $2,000 in cost.

Formerly the base was allowed to compact under traffic before it was penetrated with oil, but starting this year the penetration work is included in the original contract. Penetration consists of 7,000 gal. of road oil per mile, applied at a cost of about $600. Most of Montana's highways today are of this type, and they are in excellent shape. The writer investigated this summer a section of U.S. Route 2, near Bainville, of this type laid four years ago. The mat, though thin, is still smooth and unbroken, and digging into it revealed that the oil was still "live" and plastic despite the extreme climatic conditions prevailing in the northeastern part of the state.

After the penetrated road has thoroughly settled under traffic, and when and if traffic conditions warrant, a 2-in. mat, either plant or road mix, is applied to the surface. These mats cost up to $6,000 per mile. All kinds of bituminous materials are used for the penetration and mat work, from the cheapest oils to the highest grade cut back asphalts. Heavier or additional mats are applied where required.

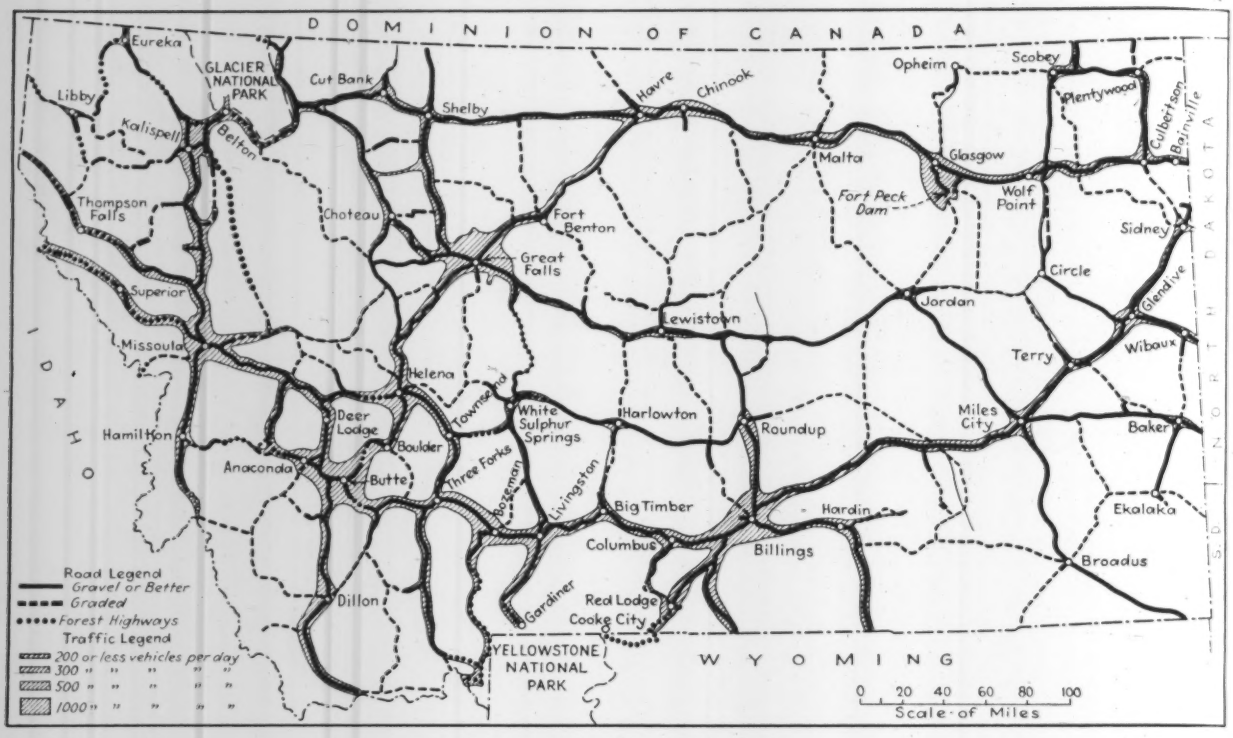
Road metal is, in general, plentiful throughout the state. Gravel abounds in most of the streams, and also in numerous bank deposits. Of course, in the mountains, crushed stone is available if gravel is not convenient to obtain. On one 86-mile stretch of road between Miles City and Jordan in the eastern part of the state, scoria was the only material available. As this rock is highly absorptive, the surface was penetrated with a high-grade cutback. Incidentally, this road gave Jordan, an inland town 86 miles from a railroad, a hard-surfaced highway before there was telephone or telegraph service in the community.

Maintenance and snow removal

Maintenance expenditures average $1,750,000 per year. Under the maintenance program is included considerable widening of old, narrow roads, and re-penetration of worn sections of thin mat surface where a heavier mat is not yet warranted. A breakdown of maintenance expenses is shown in the accompanying table. Winter damage last season, including flood loss, slides and breakdown of the older weak mats, amounted to $500,000.

Snow removal is a serious problem, and costs the state about $100,000 annually. All maintenance equipment is bought with snow-removal attachments. At present the fleet consists of 97 trucks fitted with 36 V-plows, 52 one-way plows and nine rotaries, and sixteen motor patrol graders and three tractor plows. The maintenance department has on hand 1,364,200 lin.ft. of snow fence, which is set up and taken down each fall and spring. The fence is of the woven wire wood slat type, with ½x1½-in. slats 4 ft. long spaced 2 in. apart. Steel posts 7 ft. long carry the fence.

Practically all of the state highway mileage is kept open during the winter, with the exception of four mountain passes. Marias Pass on U. S. Route 2, alongside Glacier National Park, is closed in cold weather because of extreme danger of snow and rock slides. Last season a total of 4,367 miles of road was kept cleared, at a cost of $86,226 not including repairs to equipment. In addition, some 400 miles of access (county) roads were cleared with state equipment, though the counties paid the cost of operation. This emergency work was necessary to provide means of hauling feed to stock.



ROUTE and traffic map of Montana, showing how the highways reach to all parts of the large state, and points of heaviest travel.

The first operation in snow removal is to clear a way for traffic, and subsequent operations clean the road from ditch to ditch, which permits draining of all trapped water and keeps the melting snow from getting into the road or subgrade. Wherever possible, the snow forces go out into the fields and plow ridges parallel to and 150 ft. out from the road. These have proven effective in checking further drifting.

Secondary roads poor

In contrast to the fine highways of the state system are some 75,000 miles of secondary (county) roads, most of them miserably poor. The secondary system depends solely upon the motor vehicle fees for revenues and there is little supervision or coordination of the expenditures. Few county roads have even a gravel surface, and most of them are dusty in dry weather and almost impassably muddy in wet weather.

State highway organization

Montana has a three-man highway commission, under which are a chief engineer and an assistant chief engineer, in charge of all departments. The four main departments are maintenance, preconstruction (location and plans) construction and bridge. Each department is divided into several subdivisions. At present the organization is housed in the capitol and in several office buildings scattered throughout the city, but a new highway office building is now under construction adjacent to the capitol grounds. It is a 3-story reinforced concrete structure with stucco exterior, redesigned from brick construction after the disastrous earthquake in Helena last October.

In June the highway department force numbered 1,741, including 1,200 maintenance employees. The maintenance crews are greatly curtailed during the winter season.

DISTRIBUTION OF THE MONTANA HIGHWAY MAINTENANCE DOLLAR

Item	Per Cent
General Maintenance:	
Equip and ind. insurance	1.95
Gravel surfacing	9.24
Shoulders, ditches, weeds	10.20
Unsurfaced	1.50
Slides and washouts	.96
Guard fence	1.40
Snow removal	2.22
Bridges	.43
Signs and signals	3.64
Concrete	.10
Oiled surfaces	12.64
Snow fence handling	1.27
Equipment repair	8.08
Beautification	.31
General supervision	1.75
Total	55.69
Special Maintenance and Betterments:	
Resurfacing, gravel and rock	6.87
Addition of binder	.17
Reconstruction	2.98
Guard rail	.23
Bridges	2.05
Slides and washouts	3.40
Pavement shoulders	.60
Oiling and sealing	18.16
Signs and signals	.36
Misc. items and stores accts.	.39
Total	35.21
Capital Assets:	
Equipment	5.92
Buildings	3.18
Total	9.10

The field organization is grouped into ten divisions, each under the direction of a division engineer. Division offices with more than 400 miles under maintenance also have a resident engineer as assistant to the division officer. The division officers are responsible for much of the location, design, construction and maintenance work.

Dr. H. J. McGregor is chairman of the highway commission. D. A. McKinnon is chief engineer, and E. B. Donahue is assistant chief, also is in charge of the construction department. Other department heads are: maintenance engineer, Scott Hart; preconstruction engineer, P. G. Poore; and bridge engineer R. D. Rader.

Renew Underdrains in Louisville Filters

THE JOB of renewing the underground system of the north filters of the Louisville Water Co. last year occupied seven months, ending Sept. 27 according to the annual report of John Chambers, chief engineer. The job consisted in the removal of the sand and gravel beds from all of the filter units, cutting out the old cast-iron lateral pipes imbedded in 6 in. of concrete and the removal, sandblasting and repainting of all collector piping. The collectors were replaced, new cement-lined cast-iron laterals were installed, and the washed sand and gravel which had been removed were replaced.

MOSQUITO CONTROL ENGINEERING—VI

Effective Malaria Control

Not all mosquitoes transmit malaria and eradication measures are directed primarily to members of the *Anopheles* group. Adequate drainage, larvicide distribution and screening of houses are the control methods used in curbing the spread of disease

By L. L. Williams, Jr., Senior Surgeon
U. S. Public Health Service
Washington, D. C.

IN ORDER TO CONDUCT an anti-malaria program economically it is not necessary to destroy the breeding places of all mosquitoes because the disease is conveyed only by the genus *Anopheles*. Further reduction in the cost of control can be made by distinguishing between the nine species of this group prevalent in the United States of which only two are of significance as malaria carriers, namely, *A. quadrimaculatus* in the East and South and *A. maculipennis* from New Mexico to California. The most important is *quadrimaculatus*.

The *Anopheles* mosquito is the absolutely necessary link in the transmission of malaria parasites from one human host to another. The bloodstream of an infected person is filled with these parasites which, if drawn into the stomach of an anopheline mosquito, undergoes certain growth changes. Finally, a stage of development is reached where the parasite is ready to be injected in the tiny wound made by the mosquito in biting. Thus the parasite again reaches the human host where it attacks the red blood corpuscles causing chills and fever. There are three types of malaria—quartan, tertian and estive-autumnal or tropical fever—all of which produce similar conditions.

Characteristics of the species

The malarial mosquito may be distinguished by the fact that its wings are distinctly spotted and the adult assumes a resting position with its body at about 60 deg. to the surface as contrasted with the almost horizontal position of other species. *Anopheles* may also be differentiated in the larval stage because they do not possess a breathing siphon and consequently rest on the surface of water; their movements are always parallel to the surface while other larvæ usually move vertically.

A. quadrimaculatus is usually found breeding in relatively clean water (and the water must be still) which receives sunshine during part of the day and yet has some shade either from overhanging vegetation or from aquatic growth or flotage. *A. crucians* can be found in slightly acid swamps, in water containing an excessive quantity of organic material, and also in brackish pools. Although this anopheline is a vector of malaria to a slight extent, it is not of sanitary importance. Another anopheline, *A. punctipennis*, is often found in the pot-holes and eddies of streams but this species does not convey malaria. The malaria mosquito problem of southeastern United States is concerned with *A. quadrimaculatus* only.

SPOTTED WINGS characterize *A. quadrimaculatus*, the malaria-carrying mosquito prevalent in the eastern and southern parts of the United States.

The best method of controlling the production of *A. quadrimaculatus* is by drainage of its breeding places. Rechanneling of a stream is necessary where the flow stops in summer to leave a series of disconnected pools. In such cases a small ditch should traverse the main channel and if necessary the stream should be relocated to straighten a tortuous course. After this is done, care must be exercised to fill or otherwise provide drainage for the old loops, because these ponds will be a greater menace than the pot-holes of the original stream.

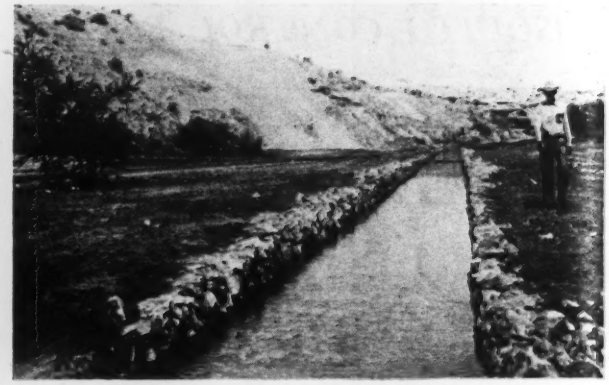
Ponded swamps would prove of little or no danger if covered with verdant forest since dense shade is unfavorable to breeding. Due to logging operations as usually practiced, our southern swamps have been made ideal for mosquito production. Large trees have been cut out, leaving open sunlit pools, a normal habitat for *quadrimaculatus*. Elimination of pools, such as these, may be accomplished by lowering the water table of the swamp by means of a relatively straight ditch following the lowest contour. A few laterals should be dug to drain depressed areas which are often found at the edges of the swamp.

Normally *quadrimaculatus* will be found only in a relatively narrow strip along the edges of a pond and in only rare instances will breeding take place from shore to shore. However, when a pond is drained not only are the larvæ removed, but with them all other aquatic life. If, after one or two years, the outlet ditch is plugged, the pond refills and as a result, the land vegetation is quickly killed and soon rises to the surface as a heavy mat of flotage. Conditions are thus made ideal for mosquito propagation and production will take place in excessive numbers because the normal fauna of top minnows and other predacious insects have not been reestablished. For a period of one to five years a refilled pond is a far greater menace than was the original. It is therefore of utmost importance that drainage ditches are carefully constructed and properly maintained.

Anti-mosquito ditches should be of a size only large enough to carry the normal water flow. The type of soil determines the slope of the ditch bank, which, in general, should be fairly steep in tough clayey material and very flat in sandy loam. Where large ditches are essential to carry a heavy winter or spring overflow, pooling in the bottom of the ditch can be prevented by cutting a ditch within a ditch. This inner ditch is easier to clean and is longer-lived if lined with concrete or other wear-resistant material.

The spoil bank on the sides of the ditch should be removed far enough from the excavation so that this weight will not cave-in the bank. Preferably the spoil should be scattered—if not, there should be a 3-ft. berm with numerous openings in the spoil bank to allow escape of rain water.

In cases where the installation of a drainage system would not be economically feasible reliance is placed on the distribution of larvicides.



DITCHES for malaria-control drainage, showing, at the left, construction of a sloped bank lateral with the spoil being scattered and at the right, a drain lined with riprap for easy maintenance.

Larvicides are available either in the liquid or dust form. Of the liquid varieties, oil is the best providing it is toxic to mosquito larvæ. Although oils can kill larvæ through suffocation this will occur only if an unbroken film remains on the entire water surface for over 48 hours. However, this is difficult of achievement because even a gentle breeze will produce large cracks in the film and eventually most of the oil will be blown against one shore. The most satisfactory type of oil is one which poisons the larvæ in from 30 min. to an hour. Kerosene is an excellent anti-mosquito oil, as are the present day fuel oils. The toxicity of the material is in almost direct proportion to its volatility.

Application of oil to a breeding area can best be made by means of a spray pump. The most convenient are those of 5-gal. capacity which can be strapped to the back of the oiler and are equipped with a Bordeau type nozzle. This nozzle can be adjusted to furnish a fan-like spray with any oil except the thick tarry types which at best, have no applicability in anti-mosquito work. The pump has an effective spray radius of about 20 ft. and distribution is fine enough so that three gallons can be spread over one acre of water surface.

If breeding areas are accessible at strategic points by motor vehicles, a light truck can carry a sufficient supply of oil for a gang of 4 or 5 laborers. Where roads are non-existent, and the larvicide must be transported by foot the cost of oiling operations becomes excessive. The transportation cost factor can be reduced, however, by utilizing pyrethrum oil emulsion.

Oil extracts of pyrethrum are commercially available and a highly concentrated emulsion can be prepared with a small agitation apparatus (see *ENR*, Aug. 13, 1936, p. 228). Since the emulsion is to be diluted with ten times its quantity of water, and as the water can be taken from the breeding area, it is obvious that the spray operator does not have to carry much larvicide. A 1- or 2-gal. can of stock emulsion is sufficient for at least a half-day's supply.

Although 5 gal. of the diluted spray must be applied per acre of breeding surface, instead of the 3 gal. application when oil is used, yet it is necessary for the laborer to carry only ½ gal. of pyrethrum emulsion.

With the aid of motor transportation, an operator can—if underbrush is not too tangled—distribute approximately 40 gal. of oil per day, which will cover a little over 10 acres of breeding surface. Each breeding place need be oiled only once a week since the mosquito life cycle in water requires this period for development. Thus one operator throughout a summer season can prevent *Anopheles* production from about 60 acres of breeding surface. Using pyrethrum emulsion at least twice this acreage can be covered by one operator.

Where oil must be applied to a large body of water the most advantageous method is by means of a centrifugal pump in a boat carrying an oil supply and powered with an outboard motor. The pump suction is adjusted to draw a large quantity of water and a small quantity of oil, mechanically mixing the two, before projecting the mixture over a radius of at least 100 ft. With this equipment two men can cover many miles of shore line in a single day.

Dust larvicides cheaper

While an oil larvicide has a distinct advantage in that it not only kills *Anopheles* larvæ, but also the larvæ of other obnoxious species, it is often prohibitive in cost. In such cases an arsenical dust larvicide, such as paris green should be considered.

Paris green mixed with any diluting dust—preferably hydrated lime—can be liberated on the windward edge of the breeding area and the breeze can be depended on to distribute the larvicide over a wide surface. The finer particles of paris green, being unable immediately to penetrate the surface tension of the water, resist wetting for some hours, and they are eaten by the *Anopheles* larvæ which feed upon the surface scum. Other species of mosquito larvæ feed below the surface and unfortunately they are unaffected by the dust poison. In the quantity generally used, paris green is not harmful to cattle, human beings, birds, or fish, nor does it harm water vegetation. Its penetrating powers are so great that only in rare instances is vegetation so dense as to exclude the dust from the water surface.

If a quarter of a pound of paris green could be evenly distributed over an acre of water surface, all *Anopheles* larvæ in that acre would ingest a lethal dose. However, with the swirling eddies of summer breezes, it is almost impossible to distribute evenly so small a quantity, and for the sake of surety it is necessary to spread from one-half to one pound to each acre.

It should be stated that arsenic is eaten by the animalcules at the bottom of ponds and in less than 48 hr. will entirely disappear from the water. Paris green has been dusted on drinking water supplies without causing any harm to human beings.

The application of paris green can be made either by hand, with a hand or power duster, or from an airplane. When breeding places are small and few in number, a mixture of 1 part of the powder with 100 parts of any diluting dust, can be adequately distributed by hand. Using the rotary hand duster loaded with a 10 per cent (by volume) mixture of paris green with hydrated lime, and walking along at a normal pace, a dust cloud can be produced that will be effective for at least 500 ft. down wind. The dusting should not be carried on if the wind velocity is greater than 7 mi. per hr.

On large lakes the leeward shore line can be dusted by power dusters from a boat; the windward shore can be worked afoot or during a calm. It is usual to use 15 per cent of paris green mixed with hydrated lime, as such a mixture will kill for a greater distance, hence making it unnecessary for the boat to follow small indentations along the edge of the lake. Where breeding areas are very large, larvicide can be effectively applied from an airplane. In this case, it is inadvisable to use mixtures less than 33 per cent paris green by weight in a heavy diluting dust, such as soapstone. Such a mixture drifting with the breeze has a lethal path of about one-half mile.

With the usual means of transportation available on an average anti-malaria project, it is customary for one man to dust about 20 lbs. of paris green per day over a surface of from 25 to 30 acres. This is about three times the area covered by one man using oil and is the minimum where breeding places are relatively small and scattered over a wide area. Where breeding areas are very large and few in number, none of the laborer's time is wasted in walking from breeding place to breeding place. It is not unusual for a man to distribute as much as 100 lb. of dust larvicide in a day over an area of 125 to 150 acres. Although oil may be purchased for 5 or 6c. per gal. and paris green costs in the neighborhood of 25c. per lb., it is usually found that the combined material and labor cost of treatment with a dry larvicide is very much less than that of oil.

Other measures of control

The problem of controlling the production of malaria mosquitoes in impounded waters requires additional procedures from those described above. In the first place, the pond must be cleared of all vegetation which extends above the water surface or which may overhang the edge of the pond and all flotage must be removed. Growth of shore line aquatic vegetation can be prevented through regular artificial fluctuation of the water surface. In addition, the flats in the upper reaches of the pond and much of the shore line must receive weekly treatment with larvicides.

In rural countries where the economic status of the people is low and where *quadrimaculatus* breeding places are large and numerous, neither drainage or larvicide distribution is economically feasible. Unfortunately, it is just such rural populations which suffer most heavily from malaria. So far, the only means of ameliorating the condition is through screening each home—in other words, where production of *Anopheles* cannot be controlled, their access to man must be prevented.

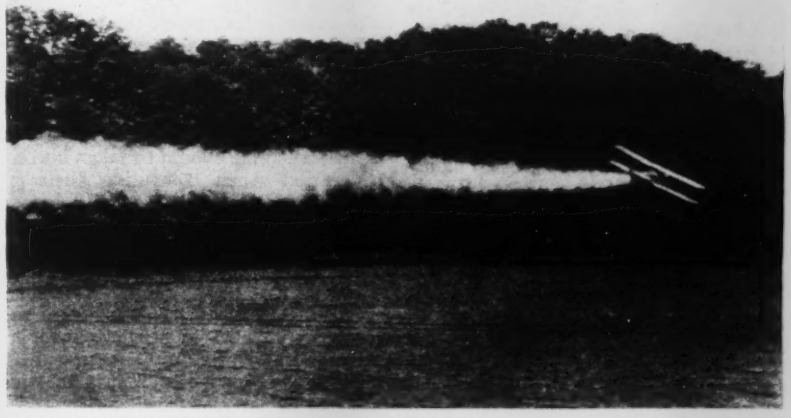
Malaria mosquitoes fly and bite only at night. If all persons in malarious areas retired into an adequately screened home at sundown and remained there until after sun-up, malaria would soon disappear.

Adequate screening of the home, using wire of 16 mesh, is a good insurance against malaria and will aid greatly in reducing the disease. In rural counties, a screening and mosquito-proofing program can be inaugurated by the county health officer with a few hundred dollars for use as a revolving fund. He can set up a small carpenter shop, purchase some lumber and a few rolls of screen wire and screen each house at cost. As he collects for the first houses, he can purchase material for others. In this way a whole county can be screened in one or two years by a health officer with an energetic sanitary inspector.

While the installation of adequate drainage is the most expensive element in an anti-mosquito program, it is also the most effective. This has been recognized in the South, where long before the advent of relief labor, many counties had embarked on county-wide anti-mosquito drainage projects utilizing convict labor. The development of larvicides and the consequent cheapening of anti-mosquito activities extended the benefits of anti-mosquito work to smaller communities, but in many cases it failed to include the strictly rural populations. In one notable instance, it was found the cost of county-wide dusting with paris green was far less than the cost of treating county-wide malaria cases.

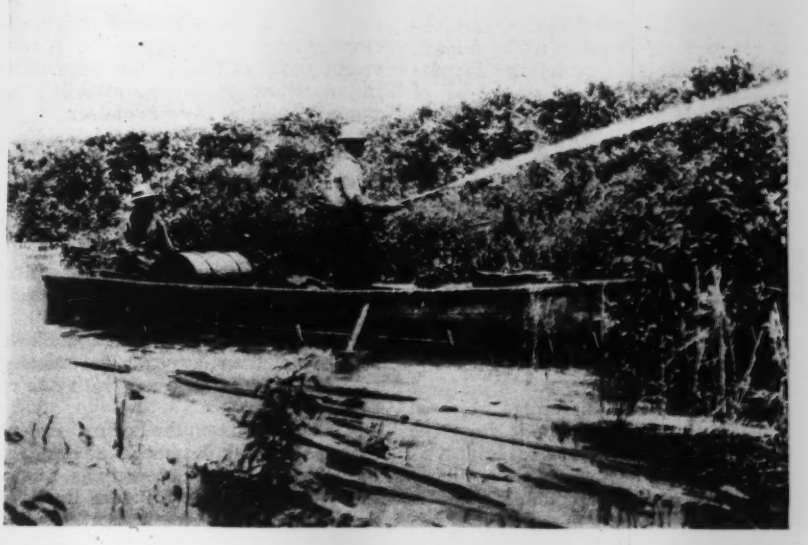
The United States Public Health Service maintains research field stations for special studies of malaria and malaria control at Washington, D. C., Memphis, Tenn., Columbia, S. C., Savannah Ga., and Panama. Present investigations are concerned with ditch lining, screening, researches on the parasite, and a search for a cheaper (perhaps biological) method for controlling the spread of the disease. In addition, the service directs the extensive anti-malaria drainage activities of the federal relief administration.

The first installment of the symposium on representative mosquito control operations will be published in next week's issue. W. S. Corkran, executive engineer, describes the work of the Delaware Mosquito Control Commission and C. M. Adams, Assistant State Director tells of the malaria control activity supervised by the U. S. Public Health Service in New Mexico.



AIRPLANE DUSTING with paris green larvicide is an effective method of covering large breeding areas. A lethal path of about one-half mile can be covered in one trip.

LARVICIDE APPLICATION along the shoreline of a lake. A centrifugal pump drawing water from the lake and oil from a storage drum projects the mixture through a nozzle in a fine spray.



Letters to the Editor

Brick Suitable for Dense Traffic

Sir—

The appearance of a letter from Sigvald Johannesson in the June 11 issue of *Engineering News-Record*, p. 855, in which he enthusiastically indorses the use of plain concrete slab without a surface as a suitable bridge pavement brings to mind the controversy which prompted his letter. In a news report in the Feb. 20 issue of *Engineering News-Record*, p. 296, entitled "Granite Block Chosen for Elevated Highway," there was a quotation from a report made by C. M. Pinckney, chief engineer of the Borough of Manhattan, to the New York Board of Estimate to the effect that brick should not be seriously considered as paving for the West Side Elevated Highway. Since there has been no statement in behalf of brick as a paving material for the metropolitan district in your columns since this report was published, I am writing to call your attention to the fact that this association, which represents the paving brick industry, has not permitted the statement in Mr. Pinckney's report to go unchallenged.

On March 25, 1936, I wrote Mr. Pinckney a letter with a view of showing him why his conclusions regarding brick pavements were erroneous and not supported by the facts. Space will not permit your publishing this letter if I quoted it in full. Following is an outline of its contents:

I agreed with Mr. Pinckney that the two-course design which includes a base course with a wearing surface is the most economical for heavy duty traffic such as occurs in metropolitan areas. The top or surface course will protect the base against temperature and climatic extremes, decrease traffic impact, check any displacement of the foundation, take the direct abrasive wear of traffic which is of special consequence in the case of chained-wheel traffic in winter, and arrest any progressive breakage or deterioration of the concrete base. In other words, a proper and adequate surface course will preserve and prolong the life of the base course to a much greater value than is represented by its additional cost. The vitrified brick type of pavement can fully meet the requirements of such a surface course and, in many respects, has advantages over any other type available.

Mr. Pinckney, in his report, referred to the unsuitability of brick from the standpoint of speed and the point was made that brick pavements are regularly constructed with a smoothness requirement as rigid as for any other type. His report also implied that modern brick pavements are "slippery when wet"; and I made the statement that I do not know of any brick pavement constructed in accordance with the standard practice of recent years in which vertical fiber lug brick were used and the filler removed from the surface on which there is a slippery warning sign. Bearing upon this, there is included in my letter, a statement to this effect by the director of highways of Ohio, in which state there are 1,500 miles of brick pavement on the state system. The advantage from the standpoint of complete filling and sealing of uniform lugs on the ends and the sides of paving brick as compared with their absence in granite block was cited. From the standpoint of safety a brick pavement is easy on the eyes of the motorist because of the low glare in sunlight and there is also sufficient color so as to make the pavement amply visible at night.

Mr. Pinckney in his report mentioned the salvage value of paving materials which we agree should be taken into consideration when computing their economic value. Data regarding the salvaging and relaying of brick pavements, particularly in the federal aid program or work relief of recent years, were cited showing that literally millions of square yards of brick pavements, some of them over forty years in service, have been salvaged and relaid. Of course in reclaiming old paving brick it is not necessary to cut or reshape them.

High wearing value found

The resistance of paving brick to concentrated chained truck traffic was shown in the accelerated traffic tests of the U. S. Bureau of Public Roads on the circular track in Arlington, Va. A more recent series of tests of the wear resisting qualities of paving materials are those described by Professor J. R. Shank, research professor of the Engineering Experiment Station of Ohio State University, and presented at the annual meeting of the American Society for Testing Materials held at Detroit in June, 1935. In his investigation, Prof. Shank used a modified Dorry stone test on various kinds of flooring materials. The values for the wear coefficients of the de-aired paving brick tested showed less wear than any of the nineteen samples of granite tested, with one exception.

Authentic data on the low maintenance expense of brick pavements as evidenced by experimental tests such as that of the U. S. Bureau of Public Roads on the Chevy Chase Experimental Road and in maintenance records were covered. The annual report of the department of public works of the city of Buffalo, N. Y., furnishes complete information on pavement maintenance costs in that city since 1889. The maintenance expense per square yard of brick has been materially less than stone block.

Dean Marston's report on the expectant service life of brick on concrete pavements in Des Moines, Iowa, as presented at the December, 1934, meeting of the Highway Research Board shows that, "in Des Moines, 91 per cent of brick pavements 16½ years old are still in service and that 60 per cent of those 33½ years of age have survived. The statement is made that, based on the retirements of brick-on-concrete pavements in Des Moines from 1919 to 1928 inclusive (10-year period), the average life would be 36 years. In view of the improvements in brick pavement design and construction methods since 1928 it is logical to expect an average (not maximum) life of much longer than 36 years for the modern brick pavement."

In his report to the New York Board of Estimate, Mr. Pinckney quotes an alleged conclusion reached at the 29th Annual Convention of the National Paving Brick Association as follows: "The conclusions on de-aired brick were that production technology and the physical characteristics of the new brick are not yet well enough determined to justify its recommendation as a standard product." I can say authoritatively that such conclusions were never reached or adopted in any way at any convention of this association. The fact that practically all of the paving brick manufacturers, during the depression period, have gone to the expense of equipping their plants for the de-airing process, many of them since the convention referred to, is proof enough that such a statement taken by itself is very misleading in its implications. On the other hand, G. A. Bole, professor of ceramic engineering at Ohio State University, considered the leading authority in this country on the manufacture of structural clay products, had this to say at the last annual meeting of this association held in February this year, regarding the de-airing method of paving brick manufacture:

> "I believe in de-aired brick. I think it is the greatest advance made in the production of heavy clay products in recent years, or may ever be made."

Mr. Pinckney also referred to an unnamed "recognized brick expert" expressing an opinion of the effect of de-airing on laminations in paving brick structure. Following is a quotation from a letter received from Dr. Bole on March 12, 1936:

> "When properly applied, de-airing eliminates lamination, thus producing a continuous phase. I make this statement after a microscopic examination of polished sections of paving brick. When improperly de-

aired, brick have hairline laminations, which are very much less than they are in the unde-aired brick."

Chicago's experience

The traffic existing in the Loop district of Chicago is comparable to that on the streets of New York. In recent years, existing surface courses, principally wood block, of these streets have been and are being replaced with paving brick. Mario T. Del Beccaro, supervisor of miscellaneous pavement repairs of Chicago, has been in charge of this replacement work. The following are the concluding paragraphs of an article recently written by him:

"The last, and equally important, item to be kept in mind is that of durability of the finished pavement. Brick streets can be expected to give good service for at least twenty years, under heavy traffic conditions. One of the smoothest stretches of pavement in Chicago's Loop area is a block, formerly paved with wooden block, which has been repaved over a period of 5 years, with brick. The brick has stood up under a traffic load seldom encountered on any street. The Chicago Surface Line Railway runs its double track down the center, and a constant flow of automobile and truck traffic pounds across it at all hours. Under such conditions few types of pavement could stand up but from the present appearance of the street, I would be willing to wager that it will be giving good service twenty years from now.

"May I conclude by saying that paving brick is, in my opinion, one of the most economical and durable types of pavements for city streets. That, in the past five years, it has been possible to replace 50 per cent of the creosote block pavements in our Loop streets with brick, by piecemeal patch-work, without excessive cost to the city of serious tie-up of traffic is the highest compliment I can pay to the use of paving brick."

Brick in New York

To cite projects closer at hand, there are a number of sections of brick pavements that have been constructed in New York City and vicinity in the last few years principally for test purposes. In June, 1931, a section of brick pavement was constructed on the Kingsbridge Road on a grade where it dips under the Grand Concourse and to date it shows no effect whatever of the severe traffic it has received. Over a year ago another test section was constructed at the New Jersey entrance to the Holland Tunnel and last November the entire inclined approach was paved with brick which replaced the existing granite block. This approach section, since its installation had had on March 1, a traffic of over 1,000,000 vehicles in the fast lane and 800,000 trucks and heavy vehicles in the slow lane. The speed limit in the Holland Tunnell is 40 miles per hour which, I believe, is somewhat greater than will be permitted on the West Side Highway. There have been no accidents recorded on the brick section and I suggested that Mr. Pinckney or his engineers inspect this and the older section as to their present condition which, to outward appearance, is perfect in every way. A comparison of the smooth riding qualities of the brick surface and the adjacent granite block is striking.

Brick compared to granite

Vitrified brick can fairly be said to approach granite block pavements in durability and at least equal them in low maintenance expense. It excels granite in smoothness, quietness, comfort of travel, safety, and ease of salvage. The cost in the New York area is approximately forty per cent less than that of granite. I certainly do not believe that in dismissing brick in summary fashion from consideration as a pavement on the West Side Elevated Highway, there was pronounced prejudice against this type or undue favoritism to another. Mr. Pinckney's standing and attainments as an engineer would preclude such an opinion. However, I am sure that his conclusions were reached because of incomplete and inaccurate information and probably also were based on a limited recent experience with vitrified brick as a paving material. We invited and respectfully urged his additional investigation of the utility and merits of this type of paving, and offered our cooperation to this end. We submit that a paving material that has been in continuous and successful use on the municipal streets and the highways of this country during the past 65 years deserves an opportunity to prove its worth on the pavements of the Borough of Manhattan.

G. F. SCHLESINGER
Engineer-Director,
National Paving Brick Association.
Washington, D. C.
June 30, 1936.

Navy Yard's Record Clear

Sir—Your editorial note "Get Men Off WPA" in the August 20 issue, p. 382, is based on a misintepretation and does the writer a serious injustice. Had the correct facts been available to you, I am sure that you would not have expressed the criticisms contained in the note.

You base your comment on the passage, "If the statements credited A. J. Brehm, director of the Navy Yard operation, are correct, the Navy has quite a different attitude toward WPA from that expressed by the President." Apparently you relied on the contents of an article printed in the New York *Times* of Sunday, Aug. 16. This article made certain erroneous statements on the conduct of the WPA projects at the Brooklyn Navy Yard.

I did say that we were increasing the pay of some of our key technical workers who, we felt, were underpaid for the class of work they are doing. We have not at any time increased the rate of pay of mechanics and laborers on our projects beyond the rates of pay fixed by the Works Progress Administration.

Part of your editorial comment deals with a statement attributed to the writer, that the Navy looks on its WPA work as a *works program*, not a *relief program*. In your comment you misconstrue the meaning of the writer's original statement. The real meannig, which I did and do desire to convey, is that workers taken from relief rolls should render service in accordance with the pay received.

Fitting men for private jobs

The work being carried out in the WPA program at the Brooklyn Navy Yard is of very diversified kind, and employs mechanics and laborers of many different kinds of skill. It is my belief that through the manner in which these projects are conducted many of these workers have not only been rehabilitated physically but also have had their morale and workmanship restored. If this is the case, obviously they become better fitted for private industry.

I have said and desire to repeat that the projects at the Navy Yard are an ideal means of providing real work for unemployed construction workers. This is especially so because the work is essential. Because of their many ramifications and the obstacles which they encounter, these operations are necessarily handled under day labor procedure. I greatly prefer straight contract work whenever it is possible, but it can hardly be made applicable to the work we have in hand.

It is the policy of the WPA at the Navy Yard to assist workers to private employment whenever possible.

A. J. BREHM
Works Manager, E. R.,
Brooklyn Navy Yard.
New York,
Aug. 28, 1936.

Bank Construction at Fort Peck

Sir—In the report of the Portland meeting of the American Society of Civil Engineers (*ENR*, July 23, p. 126), in which reference was made to the Fort Peck Dam, you quoted me as saying, "that close check is kept on the banks or shell of the dam in order to insure stability and *impermeability*." This should read, "that a close check is kept on the shells of the dam to insure their stability and *perviousness*." Special care is taken that a material which will drain well is placed in both shells. The only portion of the dam in which we are attempting to obtain a relatively impervious material is in the core.

T. A. MIDDLEBROOKS
Associate Engineer.
Fort Peck, Mont.
Aug. 1, 1936

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SOME REASON FOR ANXIETY about the preservation of essential water resources is being found in the increasing use of cold water from deep wells for air cooling, as reported in last week's news. The per capita requirement of water for such service greatly exceeds any normal consumption, and the water is just as permanently lost to underground storage as if it were poured into the sea. There is danger in this waste, for many communities (and the rural regions almost without exception) depend on wells for their vital supply. The matter of water conservation is therefore quite directly at issue. Depletion of subsurface storage often affects wide areas and requires years to make up; with increasing demand for air cooling, groundwater conservation may therefore soon compel attention by public authorities. So far, only few states have legalized public control of groundwater resources, but doubtless others will be forced to set up such control when evidence of the lowering of the water table appears. In order that any such action may be guided by adequate information, groundwater levels and capacities should be subjected to much more thorough study than they have yet received. Already a substantial amount of work in this field is being carried on by the federal Geological Survey with the cooperation of a number of the states, but this is far from adequate to supply the needed data. Both state and federal activity must be extended much farther if a factual basis for proper conservation measures is to be obtained.

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The economic discussion suggests a reluctance to speak plainly and consistently. The plight of the Great Plains is declared to be very serious, in fact there is danger of "worse disaster than has yet befallen," but nothing tangible is offered to ward off this danger except for more of the soil conservation and shelter-belt propaganda that has become current cant. The committee frankly says that the basic trouble of the Great Plains is the alternation of wet and dry periods lasting for decades, and that we are possibly now entering one of the dry periods; but here it stops its thinking, except to say that we must take steps to check the drift of the people away from the Great Plains.

Again, it reports that in less than four years the government has spent more than a hundred million dollars on conservation works in the region; but without indicating what, if anything, these works have accomplished it proposes an indefinite program of further expenditures. The committee goes out of its way to blame "mistaken public policies" for the whole trouble of the Great Plains, and concludes that therefore the government must take the lead in rehabilitation.

But it is the engineering paragraphs of the report that claim prime attention. They are quoted in full in the news report on another page, from which their superficial character will be apparent. Nothing that the committee proposes will furnish more water. The suggested improvement works include dams to prevent water erosion and to hold back water "for use during dry periods," reservoirs and wells to provide a more adequate supply for stock, and small as well as large irrigation systems. "Readjustment of water rights" to transfer water now used on poor land to nearby better land is also advocated. It is suggested that the construction of the proposed improvements may be carried out in part by the farmers individually or in groups, in part as public enterprise.

No explanation is given of whence the dams and irrigation systems are to obtain their water, or for that matter of how a country of flat relief is to provide the necessary kind and amount of storage for carryover from the wet to the dry phases of the climatic cycle. No consideration is given to the fact that virtually all streamflow has been appropriated, and that more water must be found if drought conditions are to be changed. It is quite unlikely that the "water conservation measures" which the committee recommends—which include among others contour plowing (on the flat Plains!), strip cropping and the planting of shelter trees—would supply much if any of the lacking water. Since the possibility of irrigation from wells also is quite limited, the drought problem remains substantially untouched by the report.

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CURRENT NEWS

Manager Appointed For Queens Midtown Tunnel

The New York City Tunnel Authority has appointed Col. A. W. Copp general manager of the new $58,000,000, PWA financed, Queens Midtown tunnel (*ENR*, Aug. 20, 1936, p. 285). Mr. Copp is a graduate of West Point Military Academy, and has served as an officer in the regular army. At present he is assistant state director for New York State of the PWA, in charge of the larger projects in the state, including the Triborough Bridge, the Hudson Midtown tunnel, and the Wards Island and the Buffalo sewer systems. Mr. Copp has in the past been associated with the Thompson-Starrett Co., the Barrett Co., the Lynch Construction Co., and G. H. Barnum & Co.

The plans for the tunnel have been approved by the state director of the PWA. Bids for the construction of the Queens construction shaft will be received up to Tuesday, Sept. 15. This is the first construction contract to be advertised, and as soon as the bids have been opened and the contract signed the ground-breaking will take place. The plans have also been passed by the local agencies of the War Department, and have been forwarded to Washington.

Fleming Goes to R.A.

Colonel Philip C. Fleming, recently in charge of construction of the Passamaquoddy tidal power project, has been appointed director of the inspection divison of the Resettlement Administration. Col. Fleming succeeds Col. R. B. H. Begg, who has been on leave of absence from the Virginia Polytechnic Institute, where he is head of the department of civil engineering. His leave of absence expired August 31.

Col. Fleming is a graduate of West Point and from 1926 to 1933 was stationed there as commander of the detachment of engineers, post engineer and water supply officer, and senior instructor in military engineering. In 1933 he was detailed to PWA, where he served first as executive officer and later as acting deputy administrator. He took charge of Passamaquoddy in 1935.

Shortage of Engineers In Japan

The large public and private building program necessitated in preparation for the 1940 Olympic Games to be held in Tokyo, Japan, is expected to give rise to a considerable shortage of engineers and foremen, according to Domei, the official Japanese news agency.

It is expected that about 300 trained men will be needed. The chief source of unemployed engineers is the 1937 and 1938 graduating classes. However, the universities turn out only 120 civil engineers a year, and all of them usually have jobs waiting for them when they leave school.

Walsh-Healy Act

Review of regulations for bill reveals wages will not be fixed and that only material contracts are affected

Washington Correspondence

UNDER THE PROVISIONS of the Walsh-Healy act, for the regulation of working conditions on federal contracts, the Secretary of Labor has no authority to prescribe wages. Inquiries reaching Washington indicate that this is not thoroughly understood. All the Secretary may do is to determine what is the prevailing wage in the locality for a particular industry. If the industry happens to be confined to a single plant in the community the prevailing wage in like activities may be prescribed.

A casual reading of the law leaves the impression that work on government contracts in no case could exceed eight hr. per day and 40 hr. per week. The regulations will, however, provide for overtime at a rate of pay that will be made a condition of the bid. It also is expected that requirements as to working conditions will be made a part of the invitation to bid.

The regulations will make it clear that the act will be applied only to materials. Services such as those furnished by electric utilities and common carriers are not considered as coming within the act.

Reference in the act to regular dealers or manufacturers will be construed liberally. Even those who simply assemble their product will be regarded as regular manufacturers. Brokers, however, will be eliminated except in cases where they are virtually manufacturers' agents or where they perform essential services for the Navy, Coast Guard or Revenue service. Those usually known as brokers handle certain miscellaneous supplies for ships. As ships frequently can be in port only a limited time, these types of supplies are purchased from brokers who are familiar with the detailed requirements. They really do the work of a ship's supply officer, who would not have time to purchase a large aggregate of small articles from scores of different firms during the short time his ship would be in port.

Contracts exercised outside the United States will be exempt. It is assumed that it is not the intent of the law that any effort be made to have it apply to materials purchased for the construction of a legation abroad or to purchases by naval vessels in foreign waters or by the Panama Canal.

The regulations will point out that the act is not interpreted as applying to goods in stock except in their actual handling.

Minimum wages cannot be prescribed for some time, due to the detailed investigating that will have to be done in every community in the United States.

Since the exercise of powers such as are granted in this act never have been undertaken before, exemptions will be many at the start. No attempt will be made to invoke the act except in cases where there is a history of price-cutting at the expense of payroll.

Regulations will provide that only employees engaged directly on government work are to come under the act. Office workers or power house employees, for example, will not be affected by any conditions prescribed for those who actually work on or handle the goods.

While the act does not set up a board to determine exemptions and other matters, it is expected that such a board will be created to act in an advisory capacity.

As enacted the law does not apply to contracts under $10,000. An amendment to reduce that minimum will be sought at the next session of Congress.

Some observers believe health standards that may be required under the Walsh-Healy law offer as much opportunity for the government to exercise control as does any other feature of the act.

Housing Bids Rejected

Bids submitted for the construction of the superstructure of Langston Terrace, the $1,600,000 PWA housing project in Washington, D. C., have been rejected on the ground that they are too far above the estimates. The bids rejected were submitted by J. Slotnik Co., of Boston for $1,523,000, and of Charles Tompkins of Washington for $1,555,000. Readvertisement of the job for other bids is under consideration.

P.W.A. has advertised for bids on erection of the superstructure of a $4,500,000 housing project in Detroit, to be opened September 29, and for construction of superstructures of a $1,500,000 project in Schenectady, N. Y., to be opened on September 22.

A bid of $2,488,500, submitted by Anthony T. Miller of Atlantic City, N. J. for construction of superstructures on the $3,000,000 project in Camden, N. J., has been accepted. The Turner Construction Company of Philadelphia has been awarded the contract for construction of superstructures on the $2,260,000 project in Philadelphia on a low bid of $1,152,440.

Freeing Toll Bridges In Alabama

A program for freeing 15 toll bridges in Alabama is expected to start soon. There are $3,780,000 in bonds on the bridges. These bonds, which carry 6 per cent interest, have been in default since last October. It is planned to refund the bonds at 4 per cent, and lease the bridges to the state highway department for $300,000 annually, a sufficient amount to amortize the new bonds. Holders of 75 per cent, about $2,840,000, of the bonds, must agree to the plan before it can go into operation. On August 29, holders of $2,000,000 of the bonds had signified their agreement to the plan.

U. S. Representatives To Berlin Structural Congress

Acceptance by the United States of an invitation to participate in the Second International Congress on the Building of Bridges and Structures Above Ground, to be held in Berlin, Germany, from October 1 to 8, 1936, has been announced by the Department of State. Official delegates representing this country have been appointed as follows: Robert H. Sherlock, Professor of Civil Engineering, University of Michigan (chairman); Captain Henry M. Underwood and Lieutenant Paul W. Thompson, Corps of Engineers, U. S. Army; Dr. Frank H. Constant, head of the Department of Civil Engineering, Princeton University; John I. Parcel, Professor of Civil Engineering, University of Minnesota; and Ernest E. Howard, consulting engineer, Kansas City, Mo.

Destruction Tests On Old Bridges

The British Ministry of Transport has begun a program of testing old bridges by loading them to destruction. About 12 bridges are to be tested, most of them brick and masonry arches, with a few old cast iron girders.

Tests have been conducted on one bridge, a stone arch with a span of 22 ft. A platform was erected over the bridge, carrying a load of pig lead. The weight was transmitted from the platform to the bridge by means of a pair of jacks, spaced to duplicate wheel loading. The bridge collapsed when the load was brought to 80 tons. Cracks and deformation of the bridge were observed by taking photographs, by use of an extensometer, and by observing the change in tone pitch of tight wires.

Drought Area Committee Report Urges Water and Soil Conservation

Great Plains problem found to require farming changes, dams, wells and irrigation systems

A REPORT on the drought problem of the western or short-grass region of the Great Plains, presented to the President Aug. 27 by a committee of government officials, declares the problem to be of utmost seriousness.

"Activities for permanent rehabilitation and reconstruction already undertaken must be speeded up and expanded if the Great Plains area is to avoid a worse disaster than has yet befallen it," the report says, after stating that the federal government has already spent on the region (population 2½ millions) during the 3½ years just past no less than $140,000,000 for "works related to conservation of physical assets," in addition to grants, loans and relief of $335,000,000.

Long Term Readjustment

This year's drought, following on several preceding dry years with partial crop failure, was the motive for the appointment of the committee by the President in July. The committee's trip through the drought area convinced it that "we are confronted not merely with a short-term problem of relief but with a long-term problem of readjustment and reorganization."

Unless there is readjustment of farming methods "the agricultural economy of the Great Plains will become increasingly unstable and unsafe," the committee asserts. Settlement of the western Plains occurred "at the end of what appears to have been a 40-year dry period [elsewhere stated as 1825 to 1865] and at the beginning of a wet period which has apparently terminated"; the committee believes that we may now possibly be "in the midst of a new and prolonged drought period," with subnormal rainfall for the next 20 years or more.

In addition to lack of rainfall, a large element of blame is placed on erosion: "One primary source of disaster has been the destruction of millions of acres of natural cover" of Buffalo grass by overgrazing and by excessive plowing. Blame for this is placed on federal homestead area restrictions. Serious and permanent injury by erosion is declared to be present on 15 per cent of the area and "the economic results have been general insecurity, bankruptcy, tax delinquencies, absentee ownership, and an increase in tenancy."

A Federal Problem

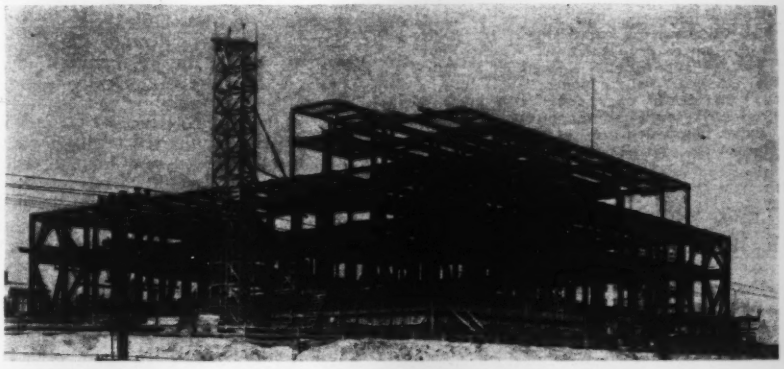
While the influence of dry farming is not mentioned directly, the report says that a prime requisite for developing an economy that will withstand the shocks of recurrent periods of drought is to "arrest the wastage of soil by erosion and make efficient use of the water resources of the region." To this end the federal government must take the initiative both in guiding and in financing the needed public works. However, the committee says, "there need not be and should not be impairment of local and individual initiative."

As a remedy it is proposed that, after engineering measures and reform of agricultural practice are studied for individual parts of the region, submarginal lands be taken out of production, while "on arable farms such soil conserving practice as regrassing, contour plowing, listing, terracing, strip cropping and the planting of shelter trees should be followed." Public acquisition of lands and establishment of public grazing ranges are suggested. Land-use zoning is proposed as a means of restraining owners from putting land to uses which will destroy it.

Engineering Works

Discussing engineering measures to aid the region the report says (in full text):

> "In a land of little rain it is imperative that water should never be allowed needlessly to go to waste. The farming practices described will help to reduce run-off and to hold water in the soil. Dams may be of use, not only in checking water erosion but in holding back water for use during dry periods. In some cases they may produce power for pumping and other local uses. Thousands of stock reservoirs and wells should be developed to provide a more adequate supply for stock. Small irrigation systems for groups of families will be found useful, and construction of large irrigation projects to supply families already in the region should be considered.
>
> "Some readjustment of water rights appears essential. It is contrary to the basic principles of conservation to allow water to be diverted to poor lands when there is not enough to supply neighboring lands of better quality.
>
> "Some of these projects may be car-



EARTHQUAKE RESISTANT FRAMING OF NEW SAN FRANCISCO MINT

In the design of the new federal mint in San Francisco every practicable means for making it safe against earthquakes has been utilized. The steel framework, now up, illustrates some of the methods used, in its heavily braced corner panels and its general symmetry. The foundations upon which the columns rest are tied together as a unit; they consist of continuous mats for the exterior and court walls and individual footings for the interior columns, tied to the mats by concrete struts. Reinforced concrete walls are to be used, which, with the heavily reinforced floor slabs, will resist and distribute the seismic shear. Column rigidity is also increased by heavy concrete encasement.

Before the building was designed, careful geological and seismological examinations of the site were made to determine its period of vibration. The design was then worked out to provide a period of vibration for the building that would not be likely to synchronize with probable earthquake vibrations. The Mint, designed by the Public Works Branch, Procurement Division, of the U. S. Treasury Department, is one of the first buildings to incorporate in its design the theories of the dynamics of earthquake loads that have recently been advanced. An article described the design in *ENR*, Oct. 3, 1935, p. 466.

ried out as a part of a work relief program, others as major public works, still others by the farmers themselves, either individually or in cooperating groups."

No further details or supporting facts on the proposed construction are given.

Special Board Proposed

The report recommends "a well devised project envisaging the entire region. There is no reason why such a project should not exist, nor why it should not be carried through without friction by local and state agencies on the one hand and federal agencies on the other." Such a project, it proposes, should be formulated by a board representative of federal and state agencies.

On the vital question of oversettlement of the region the report says: "Whether or not the region can support adequately the population now residing within its limits is a question which cannot at present be answered." It also states that it will be necessary to determine how many people the region will support under a régime of "scientific agriculture."

Although the committee finds that the drift away from the Great Plains has already begun, yet "aimless intra-regional migrations should not be encouraged." The committee recommends that "the studies and demonstrations carried on by agencies of the federal government concerned with Great Plains problems be extended and directed along lines of positive influence," and that legislation to encourage grass farming, promote resettlement, stimulate conservation, and furnish credit be studied.

The reporting committee consists of Morris L. Cooke, Rural Electrification administrator, chairman; Henry A. Wallace, Secretary of Agriculture; R. G. Tugwell, Resettlement administrator; John C. Page, Acting Commissioner, Bureau of Reclamation; Col. Richard C. Moore, Corps of Engineers; Harry L. Hopkins, Works Progress administrator; F. C. Harrington, chief engineer WPA; H. H. Bennett, Chief, Soil Conservation Service; and F. H. Fowler, director of drainage basin study, National Resources Committee.

New Jersey Assembly Plant For General Motors

Announcement was made last week that the General Motors Corp. will build a $5,575,000 assembly plant for Buick, Oldsmobile and Pontiac passenger cars in Linden, N. J. Construction of this eastern assembly plant follows close on the completion of facilities in Los Angeles for this same group of cars.

The Linden plant, to be completed in December of this year, will have a capacity of 120,000 cars annually. Located on an 80-acre site, the plant will consist of a factory 680 ft. by 1,080 ft. in plan (as compared with 560 ft. by 800 ft. at Los Angeles), of single story construction, 16 bays wide, with a two story head house 680 ft. long across the front; a two story office building 45 ft. by 200 ft. in plan; a power house; a loading dock 450 ft. long and 50 ft. wide; and a half mile oval test track. Steel framing, brick walls, and large areas of glass sash, characterize the proposed building.

Albert Kahn of Detroit is the architect.

Drought

Washington Correspondence

RAINS in parts of Montana, North Dakota, and Illinois have relieved the drought situation locally, but large areas in these states are still very dry. New York and Minnesota have had heavy rains, and drought conditions are greatly relieved; stream flow has been restored to normal for this season of the year, but ground levels are very low. There is no improvement in conditions in other states of the drought region.

Le Tourneau photo.

GRADING AN APPROACH TO GOLDEN GATE BRIDGE

The north approach will be a four-lane highway connecting the end of the bridge with the state highway at Waldo Point. The new approach has a length of 3¼ miles, including a 1,000 ft. tunnel.

Establishment of a 6 per cent grade on one early section of the project required a cut of 100 ft. and a fill of 40 ft. Earth was moved on grades as steep as 46 per cent.

Reports from district engineers of the Geological Survey follow:

Arkansas: On August 22, stream flows were about twice what they were at the coresponding time in 1934. Some towns, however, are facing a water shortage, and water for stock is becoming increasingly scarce in many parts of the states.

Illinois: Rains in northern Illinois have raised the flow of the Des Plaines River, for the week ending August 15, well above 1934. Most other rivers, however, show a flow about one-tenth that in 1934.

Indiana: Although there was some rain, stream flow continued to decrease in many parts of Indiana. During the week ending August 22, stream flow was generally lower than in 1934 and in some cases lower than in 1930. Ground water shortages have occurred in many parts of the state, and water for domestic and stock purposes must be hauled in many localities. A number of towns in southern Indiana are imposing restrictions on use of municipal supplies.

Kansas: Stream flow continued to decrease during the week ending August 15, but most rivers are still well above 1934 levels. Many wells are dry, and the hauling of water for domestic and stock purposes has increased in all parts of the state. The town of Lowell has been forced to resort to hauling water by rail in tank cars from Concordia.

Minnesota: Drought conditions were relieved, during the week ending August 22, by general rains throughout most of the state, but the effect on stream flow has not been great. However, stream flows have stopped falling in southern Minnesota.

Montana: Rain fell in northeastern Montana during the week of August 22, but the southeastern part of the state was still very dry. Stream flow had not changed materially.

Missouri: The city of Belton is now restricting the use of water. Stream flows are generally in the neighborhood of their 1934 value. The flow of the Grand River at Sumner was 36 sec. ft. as compared with 25 sec. ft. for the same period in 1934. The flow of the St. Francis River at Patterson was 12 sec. ft. as compared with 24 sec. ft. for 1934. This discharge is the minimum recorded for this station.

Nebraska: Stream flows were generally lower than in 1934 for the week ending August 22. Ground water levels in western Nebraska were about the same as last year, but wells in the Platte River Valley showed a decline in water levels and were at almost the same level as in 1934, more than a foot below the 1935 level. However, the decline has not led to a shortage in water, due to the thickness of the water bearing formation.

North Dakota: The flow of tributaries of the Missouri during the week ending August 15, was less than during the corresponding period of 1934.

South Dakota: Stream flows continued to decline during the week ending August 15 and were generally less than during the corresponding period of 1934. Flow of the White River at Ocama was 0.6 sec. ft. as compared with 62 sec. ft. for 1934. This is a new low record for this station. Water levels in wells are holding up well and are slightly better than in 1935.

New York: Drought conditions in New York State improved greatly during the week ending August 22, due to general rain from the 15th to the 17th. Most rivers are now at or above normal flows. The level of Lake George continues to drop, and on August 21 was lower than any other August 21 on record. The rain has not been sufficient to replenish the ground water, and the level has fallen steadily during the past three months. Wells have continued to go dry, and all danger will not be passed until additional rain recharges the ground water.

Ohio: Stream flow during the week ending August 22 was at the same low level as during the corresponding period in 1934.

Oklahoma: Water for stock is scarce

over the entire state, and water supplies are low in many cities. Springs are dry in many parts of the state.

West Virginia: Stream flow, in general, declined during the week ending August 22. Flow in some streams was about the same as in 1934, and in others was well below that year.

Wyoming: The flow of the Powder River at Arvada, Wyo., was 21 sec. ft. for the week ending August 13 as compared with 58 sec. ft. for the corresponding period of 1934.

Mississippi River: The flow of the Mississippi River at West Memphis, Ark., was 94,600 sec. ft. as compared with 170,000 sec. ft. during the week of August 22 in 1934.

Missouri River: For the week ending August 15, the flow of the Missouri River at Kansas City was 15,500 sec. ft., as compared with 11,400 sec. ft. for the same period in 1934.

Brief News

BIDS HAVE BEEN ASKED for completion of the Broadway low-level vehicular tunnel at Oakland, Cal. Work on the tunnel was abandoned by the contractor on June 13, the contractor claiming that ground conditions were not as represented. (*ENR*, June 25, 1936, p. 933). The bids now advertised will be opened Sept. 11.

A MEMORIAL TO WILLIAM MULHOLLAND, builder of the Los Angeles (Owens Valley) Aqueduct and pioneer of the Colorado River Aqueduct, is planned at Los Angeles, Calif. It is proposed to erect a statue of the engineer on a mountainside in Tacoima Park in the San Fernando Valley. In one hand of the proposed figure would be a transit, the other arm would be outstretched toward a flow of water down the hillside.

A HEARING WILL be held by the Corps of Engineers on September 8 on a project for construction of a series of flood control dams on the Sabine River in East Texas. The Sabine-Neches River Conservation District has been formed by the Texas Legislature for the purpose of carrying out the project. It is hoped to build four dams at a cost of about $40,000,000; the Federal Government will be asked to provide $22,500,000 of this sum.

APPLICATIONS FOR MEMBERSHIP in the American Society of Civil Engineers, during the year ending August 31, are more than 25 per cent greater than during the preceding year, and show a gain of 75 per cent over the number of applications received during the year ending August 31, 1932. This increase in applications is considered indicative of improved conditions of engineering employment throughout the country.

ACTS SIGNED BY GOVERNOR HORNER of Illinois include: An act authorizing the creation of sanitary districts within counties, and empowering such districts to enter into contracts with adjacent cities for sewage disposal. An amendment to an act enabling cities, towns and villages to contract with each other for sewage disposal; the amendment extends the provisions of the act to cover drainage and sanitary districts. An act authorizing towns of less than 500,000 population to increase from one to two mills on the dollar the tax for garbage disposal. An act validating funding bonds issued by road districts.

ST. LOUIS'S NEW $1,200,000 PIPE LINE from Stacey Park reservoir to South St. Louis has been completed. The 60-in. steel line is 13 miles long; it was laid in 40-ft. 7-ton sections. Work started on the project in August, 1934. The new line has a capacity of 60 to 100 m.g.d. On June 22 the city started work on a second pipe line extending from Stacey Park reservoir to the Howard pumping station on the Missouri River. It will be 9 miles long, require a year to complete, and cost $694,000.

A NUMBER of building and loan associations in Milwaukee have filed suit in the Supreme Court of the District of Columbia asking injunctions against PWA's Park Lawn housing project and the Resettlement Administration's Greensdale project, both in Milwaukee. These suits are similar to the five now pending against other PWA housing projects and to the one pending against the Resettlement Administration's Bound Brook project in New Jersey; all the suits allege improper delegation of legislative powers, government competition with private industry, and unjustifiable withdrawal of land from local tax rolls.

SOCIETY CALENDAR

MONTANA BITUMINOUS ROAD CONFERENCE, sponsored by Montana Highway Dept., second annual conference, Glacier National Park, Sept. 8-10.

THIRD WORLD POWER CONFERENCE, Washington, D. C., Sept. 7-12.

PUBLIC WORKS CONGRESS, joint meeting, AMERICAN SOCIETY OF MUNICIPAL ENGINEERS AND INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, Toronto, Ont., September 28-30.

CANADIAN INSTITUTE OF SEWAGE AND SANITATION, Royal York Hotel, Toronto, Oct. 1-2, 1936.

INTERNATIONAL CONGRESS ON THE BUILDING OF STRUCTURES ABOVE GROUND, Berlin, Germany, Oct. 1-8.

INTERNATIONAL CONFERENCE ON STEEL CONSTRUCTION, Berlin, Germany, Oct. 2-7.

INTERNATIONAL ASSOCIATION FOR BRIDGE AND STRUCTURAL ENGINEERING, second congress, Berlin, Germany, Oct. 1-11.

NATIONAL SAFETY CONGRESS, annual meeting, Atlantic City, N. J., Oct. 5-9.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, annual convention, Washington, D. C., Oct. 12-13.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting, Pittsburgh, Pa., Oct. 13-17.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual meeting, Knoxville, Tenn., Oct. 19-21.

AMERICAN WELDING SOCIETY, annual meeting, Cleveland, Ohio, Oct. 19-23.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, New Orleans, La., Oct. 20-23.

AMERICAN WATER WORKS ASSOCIATION, ROCKY MOUNTAIN SECTION, Denver, Colo., Sept. 21-23.

NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, New York, N. Y., Sept. 22-25.

AMERICAN WATER WORKS ASSOCIATION, NEW JERSEY SECTION; NEW JERSEY WATER WORKS ASSOCIATION; and the SOUTH JERSEY ASSOCIATION OF WATER SUPERINTENDENTS; joint meeting, Atlantic City, N. J., Oct. 23-24.

EXAMINATIONS for registration as Engineers, Land Surveyors and Architects will be held as follows:

NEW MEXICO, examination for professional engineers and land surveyors, Santa Fe, Sept. 12.

IOWA, Examination for professional engineers and land surveyors, Des Moines, Iowa, Sept. 16-18.

Personals

D. F. PETERSON, JR., formerly a junior engineer for the WPA at Provo, Utah., has accepted a position as junior road engineer for the Shoshone Indian Reservation at Fort Washakie, Wyo.

CARL G. W. SWANSON, recently acting assistant professor of civil engineering at Virginia Polytechnic Institute, has been appointed resident engineer inspector for the Resettlement Administration.

JOSEPH W. GOLDENBERG, who has recently been employed as an assistant highway engineer in the bridge office of the Illinois division of highways, has been appointed contracting engineer of the St Louis Structural Steel Co.

S. F. CRECELIUS, who has been making surveys and investigations preliminary to the canalization of the Rio Grande as project engineer for the International Boundary Commission, has been placed in charge of construction of Caballo Dam on the Rio Grande for the U. S. Bureau of Reclamation.

K. CHARLES BEAN has been appointed by the Los Angeles, Calif. Board of Public Utilities to the position of chief engineer and general manager of the public utilities and transportation department. Mr. Bean was formerly assistant engineer of the California State Highway Commission and more recently was superintendent of construction for the Los Angeles municipal engineering department.

Obituary

WILLIAM B. DAVEY, chief engineer of the Orleans Levee Board, died on August 25 in New Orleans, La. Mr. Davey had at one time been associated with the Louisiana State Board of Engineers and with the New Orleans Sewerage and Water Board.

JOHN F. KERWIN, a paving contractor of New York City and president of the McElroy-Kerwin Company died in New Brunswick, N. J., on August 23, at the age of 66.

WILLIAM E. KATES, formerly city engineer of Rochester, N. Y., died in that city on August 24.

MOSES BURPEE, consulting engineer for the Bangor and Aroostook Railway and retired chief engineer of that railway, died recently in Houlton, Maine, at the age of 89. Prior to his connection with the Bangor and Aroostock, Mr. Burpee had been associated with the New Brunswick Railway, the Canadian Pacific Railway, and the Chicago & St. Paul Railway.

IRVIN E. KELLY, 57 years old, supervisor of pumping stations for the Philadelphia division of the Baltimore & Ohio Railroad for the past 25 years, died in Wilmington, Del., on August 22.

RICHARD W. HARR, 33, a construction engineer for the Thompson-Starrett Co. of New York City, died in New Haven, Conn., on August 26.

JOHN S. MALLETTE, a civil engineer of Ravenna, Ohio, died there on August 19.

HENRY HARIG, retired president of H. Harig & Co., building contractors of Cin-

cinnati, Ohio, died in that city on August 22 at the age of 80.

JOHN F. JACKSON, civil engineer and bridge builder, died in Milwaukee on August 22 at the age of 71. Mr. Jackson had supervised construction of the vehicular bridge over the Misissippi River at Burlington, Ia., a bridge across the Ohio at Ironton, Ohio, and the ore dock at Marquette, Mich.

CONWAY R. HOWARD, formerly a civil engineer for the Chesapeake and Ohio Railway, died on August 26 in Asheville, N. C., at the age of 55.

HENRY D. BARDWELL, for 24 years water commissioner of Turner Falls, Mass., died there on August 26, at the age of 79.

CAPTAIN FREDERICK H. COOKE, head of the public works department at the Boston Navy Yard, died on August 27 in Boston, at the age of 57.

EDWARD F. O'BRIEN, construction engineer in the office of the supervising architect for the U. S. Treasury Department, died in New York City, on August 27, at the age of 68. Mr. O'Brien had built many post offices throughout the East.

JOHN N. RAUBER, president of the contracting firm of Whitmore, Rauber & Vicinus, of Rochester, N. Y., died in that city on August 31 at the age of 73.

SAMUEL T. WILLIS, an engineer connected with the Sperry & Treat Co., of New Haven, Conn., died in that city on August 31. Mr. Willis directed the construction of many buildings at Yale University.

PATRICK J. REGAN, for 38 years superintendent of the Stoneham, Mass., water department, died in Woburn, Mass., on August 31 at the age of 66.

CONSTRUCTION STATISTICS FOR THE WEEK

ENGINEERING construction awards total $37,730,000 for the week, of which $9,252,000 is private work and $28,478,000 public construction. Of the public, $4,135,000 is federal and $24,343 state and municipal. Corresponding values a year ago are: total, $27,362,000; private, $2,831,000; public, $24,531,000; federal, $14,192,000; and state and municipal, $10,339,000. This week's total represents a loss from last week's volume and the average week to date due to lower federal awards and to a private volume less than last week's total and the average week to date.

Gains are registered in waterworks, commercial buildings, earthwork, irrigation and waterways, and unclassified. Sub-totals for the week by class of work include: industrial buildings, $3,002,000; commercial buildings $5,163,000; public buildings, $4,898,000; highways, $10,429,000; bridges, $2,623,000; sewerage, $1,497,000; waterworks, $1,004,000; earthwork, drainage, $5,158,000; unclassified, $3,956,000.

The larger awards for the week include: crude oil and cracking plant, Shell Petroleum Corp., Houston, Tex., $1,500,000; first group of 12 of 400 two-story brick and tile residences, Hancock Brooke Development Corp., Pittsburgh, Pa., at Weirton, W. Va., $1,800,000; 150 homes, Garden Terrace Sub Division, Fresno, Calif., est. $1,125,000; New York State Department of Mental Hygiene, New York, $2,886,000; highways, Mississippi, $2,048,000; Iowa, $762,000; West Virginia, $560,000; South Carolina, $602,000; low level bridge over Little Hell Gate, Triborough Bridge Authority, New York, $531,000; excavation, Barge Canal from Hudson River Lock 2 at Waterford to Guard Gate 2 to Lock 8 near Scotia, N. Y., $1,343,000; dam 22, Mississippi River, Saverton, Mo., $2,111,000; additional runways, Floyd Bennett Field, New York, relief labor, $1,986,000; 75 mile pipe line from Quentin to Williamsport, Pa., Atlantic Refining Co., $800,000.

New capital for the week consists of state and municipal bond sales $8,913,000 and corporate security issues, $41,496,000. This figure includes the $40,317,000 registered by Bethlehem Steel for construction purposes.

CONTRACTS

(Thousands of Dollars)

	Weekly Average Sept. 1935	Prev. 4 Weeks	Week Sept. 3 1936
Federal Government	$9,191	$14,093	$4,135
State and Municipal	15,856	23,622	24,343
Total public	$25,047	$37,715	$28,478
Total private	3,663	10,364	9,252
Week's total	$28,710	$48,079	$37,730
Cumulative to date:			
1935	$928,735,000	1936	$1,578,017,000

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

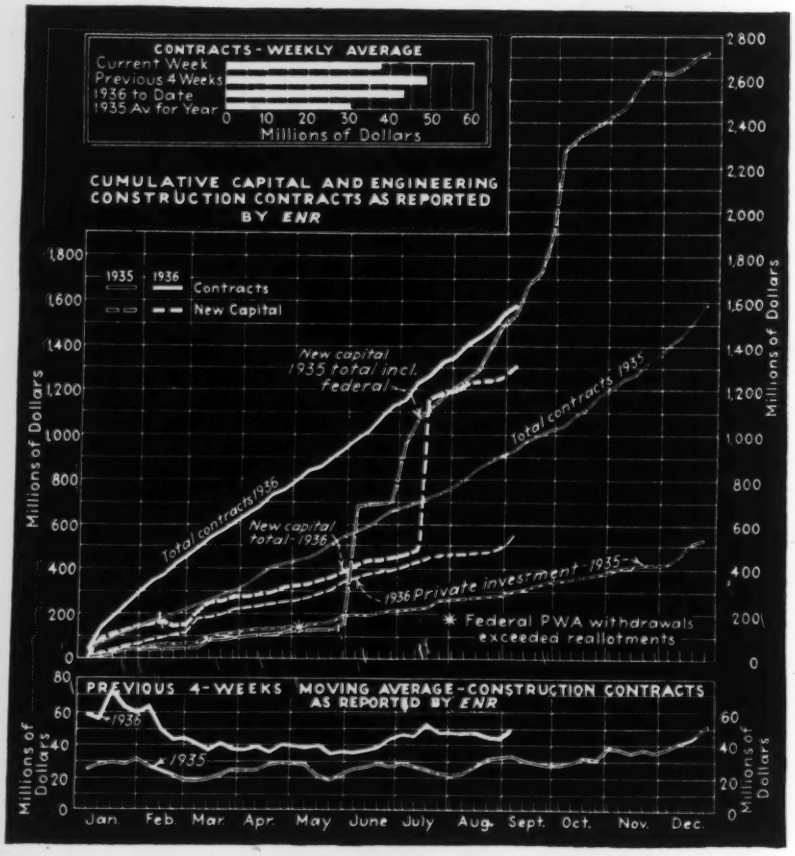
1936	Week Sept. 3	Cumulative
State and municipal	$8,913	$349,313
PWA non-federal	....	55,205
RFC loans	....	12,479
Corporate issues	41,496	198,877
PWA loans, Private	....	—1,665*
Total Non-Federal	$50,409	$614,209
Federal	....	691,237
Total new capital	$50,409	$1,305,446
Cumulative to date:		
1935	$1,536,146,000	1936	$1,305,446,000

*Bond sales in this classification exceed reallotments during current year.

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities. RFC direct purchase of bonds for "self liquidating" projects, and 25 per cent of WPA appropriations for construction projects.

INDEX NUMBER

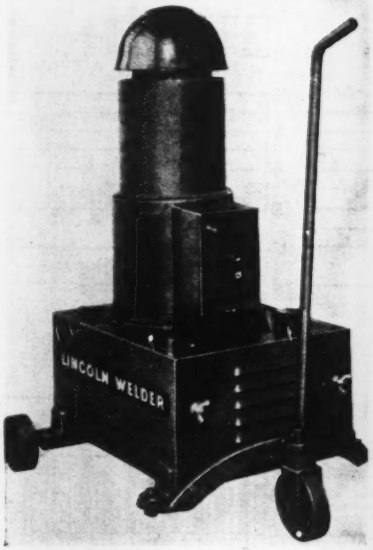
ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Sept., 1936	208.10	100.03	Aug., 1936	199	87
Aug., 1936	208.10	100.63	July, 1936	188	82
Sept., 1935	195.10	93.82	Aug., 1935	140	61
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1936 to Date
1935 Av for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1935 1936
Contracts
New Capital
New capital 1935 total incl. federal
Total contracts 1935
Total contracts 1936
New capital total 1936
1936 Private investment 1935
* Federal PWA withdrawals exceeded reallotments
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936
1935
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

Construction Equipment and Materials

A POWER-OPERATED control system is being incorporated in the new shovels, cranes, and draglines of the Link-Belt Co. The new control system is claimed to give greatly increased output and speed of operation with reduced fatigue for the operator.

FOR GENERAL FABRICATION and repair work, the Lincoln Electric Co. builds this FA-150 arc welder with a rated current range of 45 to 200 amp. Equipped with Class B insulation, and having no inflammable materials in it, the machine, it is claimed, can withstand sustained overload without injury. The welder has dual control of voltage and current, allowing independent adjustment of arc heat and arc penetration. It is powered by a 7.5 hp. a.c. motor, available for 60 cycle circuits of 220 or 440 volts.



New Worthington Compressor

Worthington Pump & Machinery Corp. is offering a line of three and six cylinder, vertical-angle, two-stage compressors in capacities ranging from 142 to 445 cu.ft. per min.

The three-cylinder unit has two low-pressure cylinders set opposite to each other at an angle, with a high pressure cylinder set vertically between them. The six-cylinder unit is set up in the same manner, with two cylinders side by side in each position. The unit may be had with Worthington Multi-V-Drive, direct-connected to the motor through a flexible coupling, or with the motor mounted directly on the end of the crankshaft.

Pistons on all models have two compression rings, two oil rings, and full-floating wrist pins.

Expansion Bolts

A new expansion bolt which is said to develop holding power up to the breaking point of the bolt has been developed by the Chicago Expansion Bolt Co. The bolt is of steel and has a thin cone-shaped steel jacket under the bolt head, with a lead jacket on the outside. When placed in a hole and driven down with the application tool, the steel cone expands over the head of the bolt wedging the bolt head in the hole and filling all space between the head of the bolt and the wall of the hole, thus preventing the lead from flowing past the head of the bolt. The lead jacket expands and flows over the steel cone, filling the hole around the shank of the bolt and giving a powerful grip between the bolt and the masonry throughout the entire length of the lead jacket. The bolt is stocked in diameters from ¾ in. to ½ in. and in lengths from 1½ in. to 8 in. Special sizes are furnished on order.

Water Metering Valve

A new automatic metering valve, a product of the Spangler Manufacturing Co., Los Angeles, Calif., has found recent application on a number of western construction jobs, notably in the manufacture of the 12 ft. 8 in. diameter concrete pipe for the distribution system of the Colorado River aqueduct. On this work (ENR June 11, 1936, p. 852) the valve is used both to meter the water for the concrete mix (to an accuracy of 0.3 per cent) and to secure automatic timed spraying of the inside of the pipe during the curing operation. In a region where water is expensive, it was desirable that the minimum water commensurate with proper curing be used. The two valves of 600 g.p.m. capacity were adjusted to flow for 56 sec. in each 20 min. during the daytime; at night, the "off" period was gradually increased to a maximum of 1½ hr. The "off" and "on" periods are controlled by a synchronous time clock electrically connected to the valves. The electrical contacts are made by pegs inserted in sockets drilled at 5 min. intervals in a circular plate which makes a complete revolution in 24 hr. By placing the pegs in the proper sockets a program of "off" cycles is scheduled in advance for the 24 hr. cycle. "On" cycles are regulated by setting controls on the metering valves themselves.

Manufacturer's Activities

Plant Expansion

• The Dewey & Almy Chemical Co., of Cambridge, Mass completed a new two-story brick office building in June. The building will house the executive offices and the stenographic and order department, and also a complete cement-testing laboratory.

• The Owens-Illinois Co.'s glass block plant at Muncie, Ind., will be expanded to more than four times its present capacity to meet an increased demand for glass masonry.

Organization Changes

• George M. Snodgrass has recently become general sales manager of the Imperial Electric Co., of Akron, Ohio. For the past 15 years Mr. Snodgrass has been with the Fairbanks Morse Company.

• The Rawlplug Company has opened a Chicago branch, which will be in charge of J. W. Gleason, formerly general manager of the Knapp Bros. Manufacturing Co.

• The Goodman Manufacturing Company has appointed Frank J. Wood chief engineer of the Industrial Manufacturing Division.

Distributor Appointments

• Appointment has been announced of the General Petroleum Corporation of California as exclusive distributors in its territory for Gargoyle industrial lubricants of the Socony-Vacuum Oil Company.

• The Robins Conveying Belt Company has made a sales agreement with the Mine and Smelter Supply Company of Denver, Colorado for the sale of Robins equipment in Arizona, Colorado, Montana, New Mexico, Utah, Wyoming and part of Idaho, Nebraska, South Dakota, and Texas.

BUSINESS SIDE OF CONSTRUCTION

August Contracts Continue Rise Public Awards Extend Gain

ENGINEERING CONSTRUCTION awards in August were heavier than for any month since January. The total for a four-weeks month is $192,317,000 or an average of $48,079,000 per week, compared with the average week to date from January 1 of $44,008,000. The gain is in federal and other public work. The total is made up of private awards, $41,455,000; public, $150,862,000 of which federal is $56,372,000 and state and municipal, $94,490,000. Corresponding values a year ago, but for a 5-week month are: total, $158,057,000; private, $32,196,000; public, $125,861,000; federal, $63,005,000 and state and municipal, $62,856,000.

Streets and roads awards were heavier than for any month in over three years, averaging about $12,500,000 per week. Building awards continued much heavier than a year ago but dropped back from the high rates of June and July. Commercial buildings continue to double last year's rate as do public buildings, while industrial building awards have held for three months at a $5,000,000 per week average.

Geographically, Middle Atlantic and West of Mississippi continue the best gains over last year. South and Middle West have established strong gains since June. New England continues on the even tenure of its way and Far West shows a moderate gain over last year.

New Capital

State and municipal bond sales total $30,000,000 in August including $4,000,000 which represents a transfer from federal to private investment financing through sale to RFC of PWA bonds. Corporate security issues totalled $8,000,000 for the month and PWA allotments $27,000,000 making total additional new capital available for the month $61,000,000.

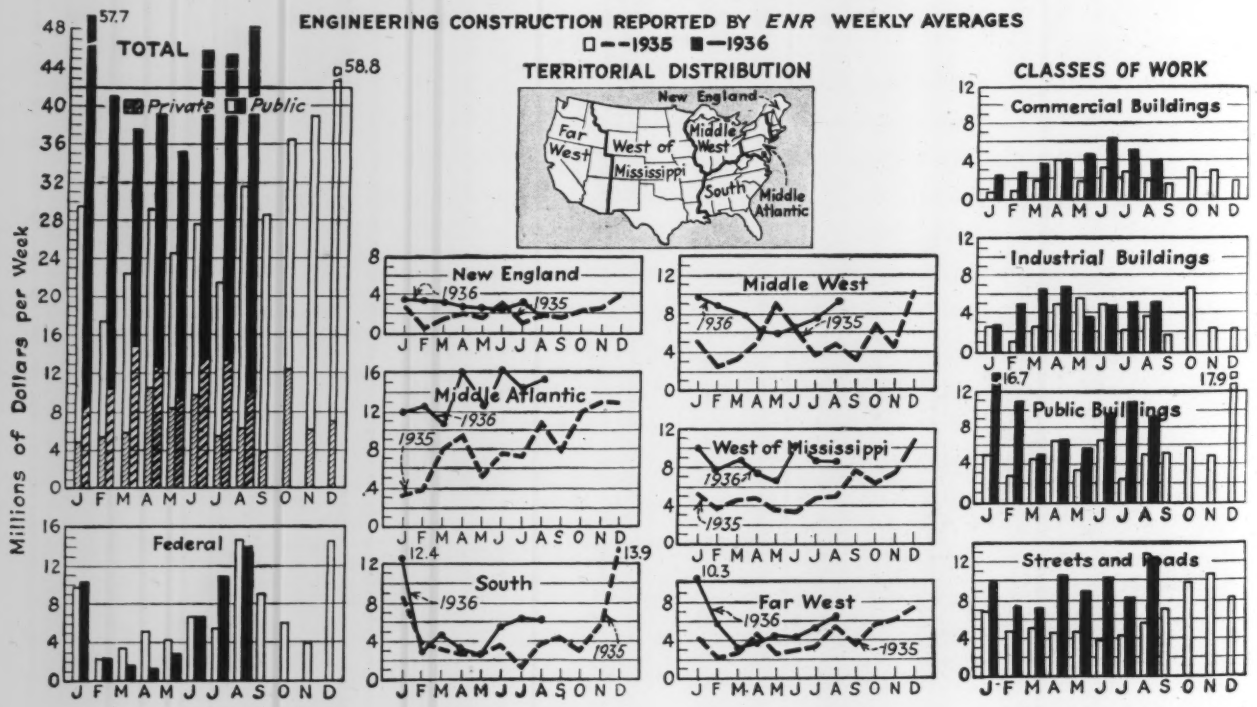
Materials

Steel—The operating rate of steel companies having 98 per cent of the steel capacity of the industry and reporting to the American Institute of Steel Construction is slightly over 71.5 per cent for August, compared with 47.7 per cent for the same period last year. The rate dropped during the month from 71.4 per cent to 70.0, then increased to 72.5.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN AUGUST, 1936

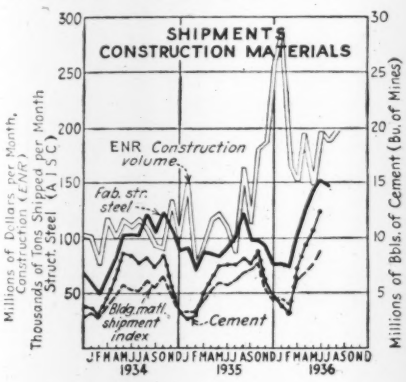
Four Weeks—Thousands of Dollars (000 Omitted)

Public Works	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States August 1936	United States Eight Months 1936	United States Eight Months 1935	Canada August 1936
Waterworks	364	482	1,107	453	1,295	2,179	**5,880**	72 236	46 456	277
Sewerage	294	3,485		3,699	1,021	124	**8,623**	90,044	44,154	740
Bridges, public	910	2,072	2,634	2,887	2,859	855	**12,217**	118,263	43,536	.....
Earthwork and waterways	390	11,451	2,405	7,715	6,084	3,912	**31,957**	129,780	155,722	473
Streets and roads	2,655	7,433	10,467	10,062	12 445	6,810	**49,872**	329,247	173,558	5,698
Buildings, public	309	15,580	2,610	6,163	7,063	5,788	**37,513**	328,625	157,923	794
Unclassified, public	44	2,407	705	285	499	860	**4,800**	66,625	37,359	258
Total public	4,966	42,910	19,928	31,264	31,266	20,528	**150,862**	1,134,820	658,708	8,240
Federal gov't (included in above classifications)	751	23,685	5,718	11,799	8,139	6,280	**56,372**	227,599	218,561	.....
Private										
Bridges, private	60	190	.....	530	31	100	**911**	9,043	9,416	.....
Buildings, industrial	1,249	3,988	3,696	7,065	2,135	2,375	**20,508**	171,063	116,755	961
Buildings, commercial	767	10,774	532	575	375	2,466	**15,489**	142,987	71,630	1,020
Unclassified, private	161	2,988	135	292	857	114	**4,547**	82,374	45,692	.....
Total private	2,237	17,940	4,363	8,462	3,398	5,055	**41,455**	405,467	243,493	1,981
August, 1936 (4 weeks)	**7,203**	**60,850**	**24,291**	**39,726**	**34,664**	**25,583**	**192,317**	.....	.....	**10,221**
July, 1936 (5 weeks)	15,503	71,374	31,444	37,388	44,211	26,675	**226,595**	.....	.....	8,685
August, 1935 (5 weeks)	9,195	55,190	18,889	22,572	25,202	27,009	**158,057**	.....	.....	.....
Eight months, 1936	101,427	479,631	196,798	271,954	299,388	191,089	.....	1,540,287	.....	63,346
Eight months, 1935	59,491	247,017	133,874	174,914	158,180	128,725	.....	.....	902,201	57,442



New business booked by the fabricated structural steel construction industry during July was the largest in volume for any month since the beginning of the depression, according to the American Institute of Steel Construction. Bookings amounted to a tonnage equal to 80.4 per cent of normal, normal being the yearly average for the years 1928-1931, inclusive. For the seven months of the current calendar year the bookings averaged 57.3 per cent of normal. Shipments of fabricated structural steel also totaled a record for the year, the volume for July amounting to 63.2 per cent of normal.

Lumber—Production reported by National Lumber Manufacturers Association for August averaged 70 per cent of 1929 weekly average and shipments 63 per cent of the 1929 average. Production has exceeded orders and shipments for 17 consecutive weeks, with production exceeding 267,000,000 ft., shipments exceeding 225,000,000 ft., and orders 259,000,000 ft.


SHIPMENTS
CONSTRUCTION MATERIALS
ENR Construction volume
Fab. str. steel
Bldg. matl. shipment index
Cement
Millions of Dollars per Month, Construction (ENR)
Thousands of Tons Shipped per Month Struct. Steel (A.I.S.C.)
Millions of Bbls. of Cement (Bu. of Mines)
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1934
1935
1936

Building Reports

As a result of the sharp drop in building permit values at New York City from the abnormally large June figure, the total value of permits issued in July in the 215 cities, which report regularly to Dun & Bradstreet, Inc., showed a decline of 15.4 per cent from June. This, however, was only slightly above the 10.5 per cent seasonal decrease usually expected at this time and, if New York City totals be excluded, there is a gain of 2.6 per cent shown for the July-June comparison. In fact, the contemplated building expenditures for July were the largest, with the exception of June, in the past five years.

Labor

Employment in the production of six major construction materials as reported by Advance Construction Programs Unit is 55.3 for July compared with 54.5 in June and 45.4 in July, 1935.

Employment in the private building construction industry reported by the U. S. Bureau of Labor Statistics, increased 0.6 per cent over the month interval while pay rolls declined 0.4 per cent. Estimated employment in this industry in July 1936 was 20.4 per cent above the corresponding month of last year and pay rolls were 35 per cent greater than in July, 1935. The reports supplied by 8,688 contractors in July, 1936, covered 96,050 employees engaged in erecting, altering, and repairing private buildings. Employees on projects financed by the Public Works Administration, Reconstruction Finance Corporation funds, or regular appropriations of the Federal, State and local governments are not included in the private building construction totals.

Employment on projects of the works program financed from funds provided by the Emergency Relief appropriation Act of 1935 was 3,042,000 in July 1936 as compared with 3,191,000 in June, a decrease of 149,000 in the number of employees. More than 2,412,000 of the total number engaged on the works program were employed on projects operated directly by the Works Progress Administration.

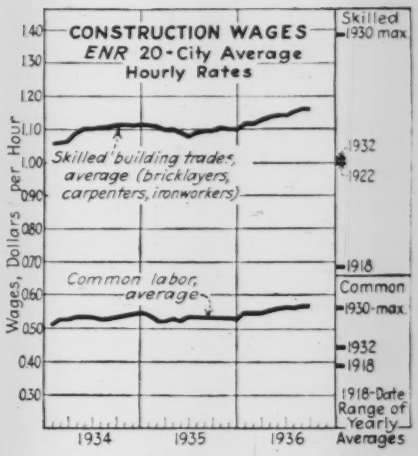
In July, over 336,000 workers were employed on construction projects financed by the Public Works Administration. A decrease of 13,000 occurred in the number of employees on all Public Works Administration projects as compared with the number employed in June.

Construction projects financed from regular governmental appropriations employed 120,000 workers, an increase of 18,000 over the number employed in June.

Construction and maintenance of state roads furnished 186,700 persons with employment in July, a slight increase over the previous month.

Current labor controversies center almost entirely in the WPA. Outside of WPA wage rate discussions, the International Carpenters' Union Local No. 433 of Belleville, Ill., has served notice on all contractors asking for a 20 per cent increase in wages by September 15. The present scale is $1.25 an hour. A strike is holding up a PWA school in Elizabeth borough, Pa., because union men refuse to work with non-union. Union plasterers went on strike August 17, on the new Interior Department building in Washington, D. C., demanding an increase of 25c. an hour to $1.75.

Evidence of actual or prospective skilled labor shortage begins to roll up. The Impartial Wage Board in San Francisco, effective July 1, discontinued the 6-hour day which had been in effect for months and returned to an 8-hour day, the reason given being that there was developing a shortage of skilled labor.



The California Chapter of the Associated General Contractors reports in its July bulletin to members, "The labor situation continues to be an engrossing factor in the industry. So far, while there has been a definite shortage of mechanics in certain areas, yet such shortage does not apply to all the northern part of the state and if the 130 hour provision can be removed from PWA work it will eliminate a great deal of endless grief as mechanics will be glad to go into outlying districts providing that they can be assured steady employment throughout the month."

The Federal Housing Administration issued on July 20 a trade release stating that many sections of the country report shortage of skilled building artisans due to continued improvement in residence construction activity.

A shortage of skilled workers on relief rolls threatens, under present policy of alloting PWA funds in proportion to amount of labor taken off relief, to curtail the rate of making PWA allotments to states and municipalities.

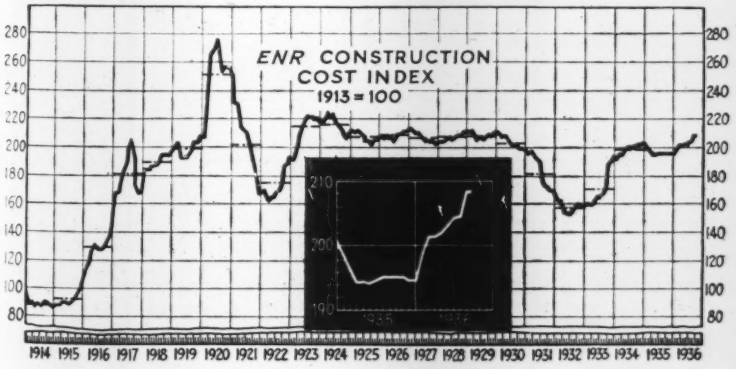
ENR Cost and Volume Index

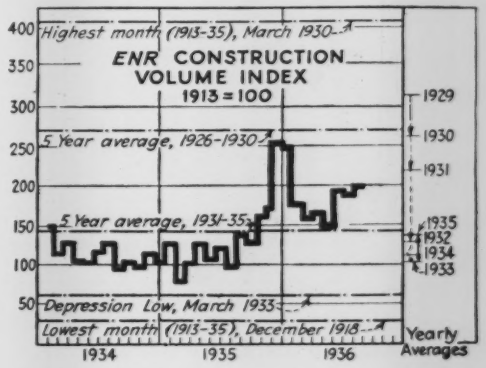
THE *Engineering News-Record* Construction Cost Index remains constant at 208.10 for September.

The *ENR* Volume Index rises to 199 for August.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Sept., 1936	**208.10**	**100.03**	**Aug., 1936**	**199**	**87**
Aug., 1936	208.10	100.63	July, 1936	188	82
Sept., 1935	195.10	93.82	Aug., 1935	140	61
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47





CURRENT PRICES OF CONSTRUCTION MATERIALS

CEMENT, AGGREGATES AND READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT (Per bbl., carload lots, including 40c. per bbl. for bags, cash discount not included)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE (Ready Mixed 1:2:4, 50c.y. or more, delivered)
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.83	$2.58	$2.50	$1.60	$1.60	$1.55	$1.69	$1.92	$1.69	$1.69	$8.50
Baltimore	2.66	2.41	2.21	1.80‡	1.80‡	1.30‡	1.80‡	1.80‡	1.80	1.80	7.35
Birmingham	2.40	2.15	1.95	1.80	1.80	1.45	1.00	1.00	.90	1.15	5.45
Boston	2.42	2.12	1.92	1.40	1.40	.90	1.40	1.40	.....	.....	6.50
Chicago	2.50	2.25	2.10	1.50	1.50	1.80	1.32	1.32	1.00	1.00	.....
Cincinnati	2.50	2.25	2.05	1.20	1.20	1.30	1.80	1.80	.....	.....	6.70
Cleveland	2.41	2.16	.....	1.40	1.40	1.40	1.60	1.60	1.75	1.75	7.85
Dallas	2.45	2.20	2.00	1.55	1.55	1.30	1.95	2.05	.....	.....	7.00
Denver	3.09	2.84	.....	1.20	1.40	.90	.....	.....	.....	.....	.....
Detroit	2.25	2.00	1.80	1.25	1.25	1.10	1.50	1.75	1.35‡	1.45‡	5.95
Kansas City	2.51	2.26	2.06	1.85	1.85	1.25	1.85	1.85	.....	.....	7.65
Los Angeles	2.32	2.12	.....	1.20	1.20	.90	1.20	1.20	.....	.....	6.31
Minneapolis	2.80	.....	2.35	1.00p	1.00p	.25p	1.00p	1.00p	.....	.....	6.75f
Montreal	.....	2.62	1.70	.80	.85	1.00	.85‡	1.20‡p	.....	.....	4.50g
New Orleans	2.47	2.22	2.00	1.50	1.50	1.25	.....	.....	.....	.....	8.25
New York	2.70‡	2.45‡	.....	1.20†k	1.20†k	.70†k	1.75†k	1.85†k	.....	.....	8.00
Philadelphia	2.68	2.43	2.23	1.45‡	1.55‡	1.15‡	2.60‡	2.75‡	1.00‡	1.00‡	8.00D
Pittsburgh	2.46	2.21	1.61	1.50‡	1.50‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.00
St. Louis	2.53	2.28	.....	1.55‡	1.40‡	1.25/1.40‡	.75p	.75p	.65/.95§	.50/.95§	6.95
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	.....	.....	7.53
Seattle	2.95	2.70	.....	1.00	1.00	1.00	1.44	1.44	.....	.....	6.75

*10c. allowed for each returnable bag. †Per cu. yd. ‡Delivered. §F.o.b. Granite City, Ill. kBarge lots alongside dock. pf.o.b. plant. f5 tons or more. gWithin 3-mi. from Pub. Square. kton. d 5% discount for cash. D Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Alpena, Mich.	$1.50	$1.45	Ironton, Ohio	$1.50	$1.45	North Birmingham, Ala.	$1.75	$1.70
Buffington, Ind.	1.70	1.65	Iola, Kans.	1.70	1.65	Richard City, Tenn.	1.85	1.80
Crestmore, Calif.	1.72	.....	La Salle, Ill.	1.70	1.65	Saginaw, Mich.	1.40	1.35
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind.	1.70	1.65	Steelton, Minn.	1.80	1.75
Hannibal, Mo.	1.70	1.65	Mason City, Ia.	1.70	1.65	Universal, Pa.	1.65	1.60
Hudson, N. Y.	1.75	1.70	Norfolk, Va.	1.76	1.71	Waco, Tex. (Plus 5c. Tax in Texas)	1.75	1.70
Independence, Kans.	1.70	1.65	Northampton, Pa.	1.65	1.60	Wyandotte, Mich.	1.45	1.40

Cash Discounts, Cement, to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount, 10c. per bbl. for payment within 15 days of date of invoice.

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE—PARTITION—SCORED (Per M, lots of 2,000 pieces or over)			STRUCTURAL CLAY TILE—LOAD BEARING—SCORED (Per M, lots of 2,000 pieces or over)			BRICK (Per M, in quantity)		LIME (Per ton, carload lot)		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Hydrated finishing	Common hydrated	Pulverized or lump
Atlanta	$71.10	$75.80	$142.10	$170.50	$199.00	$227.40	$12.25	$14.25	$18.50	$13.00	$13.00
Baltimore	91.00	98.00	183.00	219.00	315.00	390.00	13.00	17.00	20.00	14.00	25.00
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	19.00	3.00§	1.75§	2.25§x
Boston	79.90,t	85.20,t	159.75,t	181.05,t	237.30,t	271.20,	14.50	18.00	20.00	15.50	3.50x
Chicago	66.00	70.40	132.00	174.30	214.40	245.00	10.20	11.20	18.00	13.40	14.00
Cincinnati	58.85	62.80	117.75	141.30	169.26	209.56	17.50	17.50	15.97	12.48	.....
Cleveland	45.00	48.00	90.00	108.00	138.50	158.50	13.75	13.75	16.00k	14.00k	2.65k,
Dallas	68.00	67.00	140.00	160.00	190.00	260.00	13.00	24.00	19.00	16.00	1.55p
Denver	78.50	88.00	141.50	166.50	196.00	225.00	11.50	15.00	30.00k	22.00k	22.50k
Detroit	71.85	76.65	143.70	230.00	280.00	325.00	12.50	13.50	18.00	15.00	15.25
Kansas City	64.50	66.50	81.00*	125.50	159.75	186.25	13.00	22.00	18.90	12.40	10.35
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	11.50	14.00	18.70	.....	19.70
Minneapolis	80.15s	85.50s	145.40s	167.75s	175.25s	243.70s	13.10	15.10x	25.50	21.00	23.00
Montreal	84.00s	96.00s	180.00s	273.00	.....	.....	20.75	31.00	15.00	10.00	7.00
New Orleans	69.10	69.10	129.50	155.40	203.40	251.80	14.00	.....	18.40	11.25	.....
New York	78.40	83.60	125.40*	193.30†	238.80†	295.60†	12.50	.....	20.00	15.50	20.00
Philadelphia	86.00	90.00	150.00	200.00	240.00	280.00	18.00	20.00	16.35	11.25	10.75
Pittsburgh	58.40c	62.30c	116.85c	165 00c	217.00c	250.00c	16.50	25.00	17.20	14.50	2.22p
St. Louis	62.00	65.00	120.00	180.00	234.00	280.00	15.00	18.00	22.00	16.00	2.30p
San Francisco	84.00	94.50	225.00	.....	.....	.....	15.00	18.00	.55§	.40§	2.05,
Seattle	84.00	95.00	180.00	198.00	.....	.....	15.50d	18.50	30.00	20.00	28.60,

6x12x12 in. †F.o.b. Perth Amboy, N. J. ‡Per sack. §Per bbl., 200 lbs. pPer bbl. 180 lbs. gper bbl. 280-lb. kLCL. dless $1 cash 15 days. xlump. tSmooth. xSelected common. fCarload lots delivered to job.

ROAD SURFACING MATERIALS—F.O.B. CITY

	PAVING BRICK AND BLOCKS			PAVING ASPHALT		ASPHALT BINDERS—FLUXES		CUTBACK ASPHALT		ROAD OILS		ASPHALT EMULSION	
	Granite per M, lots of 50,000, 4x4x8 in.,	Brick per M, 3x4x8½ in., carload lots	Wood per sq.yd., 3½ in., 16-lb. treat,	Per ton, less than 80 penetration, Tank car	Drums	Per gal., 80-300 penetration, Tank car	Drums	Per ton, Tank car	Drums	Per gal., Tank car	Per gal., Tank car	Drum
Atlanta	$ 75.00	$35.00	$2.25	$17.40z	$ 2.62z	$0.0687z	$0.100z	$18.15z	$26.20z	$0.687z	$0.0875	$0.0875
Baltimore	108.00	44.00	2.25	17.00	22.00	.075	.10	.09†	.125†	.....	.....	.....
Birmingham	110.00	25.00	.....	19.00	24.00	.0878	.1128	.10†	.137†	.....	.06	.....
Boston	75.00	26.00	2.75	17.00	22.00	.07e	.095e	.09†e	.12†e	.07e	.095e	.125e
Chicago	125.00	42.00	1.985	16.00	20.00	15.00	19.00	.07	.11	.045	.09	.135
Cincinnati	115.00	37.00	.....	13.47	17.47	.12	.....	17.00	.....	.055	.08	.....
Cleveland	100.00‡	32.75	2.85	17.00	21.00	.07	.08	.075	.045†	.0525	.085	.095
Dallas	.....	30.00	.....	18.00	21.75	.065	.16	18.75	26.25	.055	.085	.11/.135
Detroit	.....	37.00	.....	16.80x	21.00x	.....	.....	15.25	20.25	.055	.11	.15
Kansas City	.....	40.50	.....	18.50	23.50	17.50#	22.50#	.077†	.107†	.057	.11	.15
Los Angeles	.....	50.00	.....	10.34	14.50	10.34#	14.50#	10.34	.....	.042	.06	.12
Minneapolis	.....	.....	1.75l	18.20	24.70	.098	.098	21.85	34.65	.048	.....	.....
Montreal	85.00	60.00	3.62	14.00	19.66	.07	.093	19.00	26.50	.07	.135	.165
New Orleans	100.00	32.00	.....	15.20	18.75	.068	.095	.075†	.10†	.....	.0785	.11
New York	120.00§	65.00	2.75	17.00	22.00	.075	.10	.09†	.125†	.....	.075	.11
Philadelphia	110.00	45.00	2.25	13.50	18.00	.05	.08	.05†	.08†	.045	.08	.....
Pittsburgh	115.00	40.00	.....	19.00	24.00	.0775	.1125	.086†	.121†	.0675	.....	.....
St. Louis	115/120	35.00	.....	19.70	24.70	.08775	.1075	.0825†	.1125†	.045	.09	.12
San Francisco	.....	50.00	.....	12.00	18.00	12.00#	18.00#	12.50#	23.00#	.04	.0575	.117
Seattle	.....	35.00	.....	25.50	25.50	17.00#	23.00#	15.00	.....	.03	.19	.20

Note: Paving asphalt, tank car or boat, f.o.b. Maurer, N. J., per ton, Bermudes, $25.00; Trinidad, $21.00. *Per sq. yd. †Per gallon. ‡4½x6x5½ in. #per ton §4x5x9-in. Av. xMexican. zLocal reduction due to 20% reduction intra-state class freight rates, only Georgia affected. l 2½ in. 6 to 8-lb. treatment. e F.o.b. Everett

CURRENT PRICES OF CONSTRUCTION MATERIALS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS	RIVETS	WIRE NAILS	SHEET PILING	STEEL RAILS (Per Gross Ton)			TRACK SUPPLIES			
		¾-in. billet,	¾-in. structural	Base	Base	Standard	Light	Re-rolled	Angle bars	Std. spikes	Tie plates	Track bolts
Birmingham	$2.05	$2.10	$3.15	$2.25	.....	$36.375	$35.00	$34.00	$2.55	$2.60	$1.90	$3.60
Chicago	1.95	2.10	3.15	.....	$2.35	36.375	35.00	34.00	2.55	2.60	1.90	3.60
Pittsburgh	1.90	2.05	3.05	2.10	2.25	36.375	35.00	34.00	2.55	2.60	1.90	3.60

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

F.O.B. WAREHOUSE	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¾ in., base price		EXPANDED METAL LATH (Per 100 sq.yd., carload lots)		WELDED FABRIC REINFORCING (Per 100 s.f., carload lots)		6x6 in., No. 6 & 6 wires Per sq.yd	SHEET PILING Per 100 lb. base price
		New billet	Rail steel	Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires		
Atlanta	$3.36	$2.34	$2.19	$21.00	$23.00	$1.53	$1.16	$0.1449	$2.70
Baltimore	3.00	2.75	2.60	24.00	26.00	1.41	1.08	.1332	2.45
Boston	3.64	2.923	1.962	22.00†	24.00†	1.46	1.12	.1449	2.57
Chicago	3.20	2.10	1.95	20.00	22.00	1.40	1.08	.1323	2.35
Cincinnati	3.40	3.25	3.25	25.01	29.50	1.39	1.07	.1287	.....
Cleveland	3.31	2.75	2.60	20.00	22.00	1.37	1.06	.1287	.....
Dallas	3.45	2.825	2.675	22.00	28.00	1.63	1.23	.1548	3.005
Denver	3.95	3.76	3.61	22.00	25.00	1.68	1.26	.1584	.....
Detroit	3.52	2.20	2.05	20.00†	22.00†	1.41	1.08	.1323	2.53
Kansas City	3.85	2.75	2.60	19.00	21.00	1.50	1.14	.1422	2.79
Los Angeles	2.35	2.475	.....	23.00	27.50	1.68	1.26	.1584	2.65
Minneapolis	3.55	2.86	2.71	22.00	26.00	1.51	1.15	.1431	2.67§
Montreal	3.25	2.15	2.15	32.50	35.50	2.46	1.82	.253	.....
New Orleans	.....	.....	.....	20.50	23.50	1.54	1.17	.1458	.....
New York	3.47	2.50	2.35	19.50	21.50	1.44	1.11	.1359	2.50
Philadelphia	3.10	3.06	2.22	20.00	24.00	1.42	1.09	.1332	2.56
Pittsburgh	1.90‡	1.85‡	1.90‡	20.00‡	22.00‡	1.34	1.04	.1260	2.25
St. Louis	3.55	2.45	2.30	22.00	25.00	1.42	1.09	.1341	2.30
San Francisco	3.40	2.475	2.325	23.00	28.00	1.68	1.26	.1584	2.60
Seattle	3.55	2.50	.....	24.50	26.50	1.68	1.26	.1584	2.60

‡Base Mill Price. Note: Shapes, bars and piling subject to quantity discounts. §Mill Price plus freight to Minneapolis. ††f.o.b. delivered.

PAINTING AND ROOFING SUPPLIES—F.O.B.

	RED LEAD Per 100 lb. in 500-lb. lots	WHITE LEAD Per 100 lb. in 500-lb. lots#	READY-MIXED PAINT Per gal., drums			ROOFING SUPPLIES Carload lots, f.o.b. factory				
	Dry	in oil	Graphite*	Aluminum†	Ferric Oxide‡	Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating, per gal.	Tar pitch, 350-lb. bbl., per ton
Atlanta	$7.75	$11.00	$1.60	$2.50	$1.40	$1.84	$1.61	$1.61	$.36	$25.60
Baltimore	7.00	10.50	1.45	2.25	1.70	2.03	3.00	3.00	.35	25.00
Birmingham	7.25	11.00	2.35	2.35	1.85	2.01	1.77	1.77	.36	22.00
Boston	7.00	10.50	1.80	2.60	.05x	1.75	3.15	3.15	.43	20.00
Chicago	7.00	10.50	1.35	.....	.....	2.47	2.23	2.24	.32	33.00
Cincinnati	7.00	10.50	1.45	2.50	1.40	2.40	2.39k	2.39k	.36	21.00
Cleveland	7.00	10.50	1.70	2.45	1.40	1.55	1.75k	1.75k	.23	19.00
Dallas	7.25	11.50	1.80	2.10	.....	2.35k	3.80	3.80	.14	35.00
Denver	7.50	11.25	2.55	.....	.....	2.25	3.55	3.55	.35	30.00
Detroit	7.00	10.50	1.65	2.30	1.40	2.50	2.65	2.50	.35	30.00
Kansas City	7.00	10.62½	1.65	2.65	1.10	1.78	3.15	3.15	.25	24.50
Los Angeles	7.25	10.75	1.60	2.25	2.30	2.00	1.50	.....	.45	.....
Minneapolis	7.00	10.62½	.....	.....	.....	1.60v	1.52kv	1.52kv	.29	23.80
Montreal	.....	8.20	2.00	4.75	2.40	2.50	1.60	1.83	.50	1.52§
New York	7.00	10.50	1.75	2.35	1.50	1.60	1.52k	1.52k	.232	22.00
Philadelphia	7.00	10.50	2.50	2.95	1.50	1.68	1.86k	1.48k	.37	22.00
Pittsburgh	7.00	10.50	1.05	1.95	.80	1.75	1.65k	1.65	.38	25.00
St. Louis	10.00	10.50	1.85	2.45	1.30	1.83k	2.57	2.57	.25	25.00
San Francisco	7.25	10.75	1.80	2.75	1.10-2.00	1.89	3.10	3.10	.38	26.00
Seattle	7.25	10.75	1.80	2.85	2.20	3.30	2.66	2.60	.60	30.00

*U. S. War Dept. Spec. 3-49A. †ASTM Spec. D266-31. ‡80% maximum ferric oxide. §Per 100 lb. kPer roll, 65 lb. xPer lb. v Minneapolis & vicinity
Note: Red lead in oil 50c higher than white lead in oil. #Basis of quoting changed this month from list to 500-lb. lots.

MISCELLANEOUS ITEMS

	WINDOW GLASS Discounts from latest jobbers List, Sept. 15, 1928 Single or Double Thickness		EXPLOSIVES Per lb. dynamite delivered 50-lb. cases Gelatin	
	A quality	B quality	40%	60%
Atlanta	85%	85%	$0.135	$0.15
Baltimore	88%	90%	.145	.16
Birmingham	88%	90%	.095	.11
Boston	88–10–5%	90–10–5%	.13	.145
Chicago	87%	88%	.135	.15
Cincinnati	89–10%	91–10%	.27	.29
Cleveland	85%	85%	.215	.225
Dallas	87%	89%	.1350	.1500
Denver	88%	90%	.145	.16
Detroit	87–10%	89–10%	.204	.235
Kansas City	85–10%	86–10%	.35	.15
Los Angeles	90%*	90–40%	.1725†	.1925†
Minneapolis	86%	87%	.145	.16
Montreal	60–30%	70–5%	.1825	.1950
New Orleans	88%	90%	.215	.23
New York	89%	90%	.215	.23
Philadelphia	89%	90%	.13	.1450
Pittsburgh	88%	88%	.10	.115
St. Louis	89%	89%	.13	.145
San Francisco	80%	85%	.1475	.1625
Seattle	90–10%	90–20%	.1425	.1575

*Disc. from list Aug. 1, 1929. †F.o.b. Arsenal. ‡Double thickness A & B.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York.

Bleaching powder, in drums, F.o.b. works, per 100-lb	$2.00–2.10
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competition, per ton	22.00–34.00
Chlorine cylinders, per lb. delivered	.055–.06
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb	1.35
Soda ash, 58%, in paper bags, per 100 lb. dense	1.25
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	27.00–30.00
Sulphate of copper, in bbl., per 100-lb	4.00–4.25

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf—Barge	Short Leaf—Rail	Long Leaf—Barge	Long Leaf—Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.15	$0.195	$0.16	$0.19
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.24	.18	.23
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.20	.255	.19	.24½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.225	.265	.23½	.27½
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2425	.275	.27½	.33½
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.305	.415	.....	.....
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.345	.482	.....	.....

RAILWAY TIES

Prices f.o.b., per tie, for carload lots:		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$1.10	$1.60
	Pine, untreated	1.25	1.70
	Pine, creosoted	1.65	2.30
New York	Long-leaf sap pine, untreated	.90	1.10
	Mixed oak, untreated	1.10	1.30
	White oak, untreated	.85	1.35
Birmingham	Red oak, creosoted	1.50	1.70
	Southern pine, untreated *6x8x8'6"	.55*	.70
	Southern pine, creosoted	1.10*	1.30
Chicago	White oak, untreated	1.15	1.40
	Oak, empty cell, creosoted	1.50	1.88
	Oak, zinc treated	1.40	1.70
	Southern pine, creosoted	1.35	1.78
Los Angeles	Fir, untreated	.50	.72
	Fir, creosoted	1.67	2.40
Philadelphia	Red oak, untreated	1.00	.....
	Red oak, creosoted	.....	2.10
	White oak, untreated	1.03	1.45
St. Louis	Red oak, untreated	1.10	1.40
	Red oak, creosoted	1.50	1.95
San Francisco	Sap Pine or cypress, untreated	.85	1.20
	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.10
	Birch or maple, creosoted	1.25	1.55

CURRENT PRICES OF CONSTRUCTION MATERIALS

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE	VITRIFIED SEWER PIPE				CLAY DRAIN TILE		CONCRETE SEWER PIPE		WROUGHT STEEL PIPE			
										Full standard weight. #			
	Per net ton, f.o.b. 6 in. to 24 in.*	Per foot, delivered, ASTM C 13-35				Per 1,000 ft., carload lots, f.o.b.		Per ft., delivered; ASTM C 14-35		1 to 3 in., Butt Weld		3½ to 6 in., Lap Weld	
		8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	6 in.	8 in.	12 in.	24 in.	Black %	Galv. %	Black %	Galv. %
Atlanta	$43.00	$0.25dl	$0.45dl	$1.625l	$4.50l	$80.00	$128.00	$0.45	$1.625	49.5	40.5	47	37.5
Baltimore	46.50	.28	.54	2.38	7.18	110.00	170.00	.40	1.60	....	....	....	....
Birmingham	39.00	.25	.45	1.625	4.66	85.00	220.00	.40	1.60	69.5	61.5	67	58.5
Boston	46.50	.224	.432	1.98	5.845	99.00	153.00	.42	2.35	....	....	....	....
Chicago	47.50	.245	.4725	2.025	4.60	60.00	120.00	.36	1.42	58.75	48.75	55.625	45
Cincinnati	46.00	.189	.3645	1.62	5.535	69.00	108.00	.40	1.40	58.75	48.75	55.625	45.00
Cleveland	47.50	.168	.324	1.44	4.1225	42.50	88.50	.32	1.58	61	51	57.9	47.25
Dallas	51.00	.35	.67	2.70	.....	165.00	260.00	.46	1.57	69.5	61.5	67	58.5
Denver	59.00	.27‡	.47‡	1.98‡	.....	105.00	180.00	.....	.....	50	40	47	36
Detroit	47.50	.203	.3915	1.71	5.2375	82.00	136.00	.35	1.20	59.3	49.3	56.1	45.5
Kansas City	49.00	.30	.54	2.16	5.00	120.00	140.00	.40	1.50	55	45	51.5	41
Los Angeles	47.50	.2825‡	.508‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00	62.1	54.1	59.6	51.1
Minneapolis	49.50	.24‡	.432‡	1.728‡	4.60‡	.....	.....	.65	1.65	....	....	....	....
Montreal	50.00	.33‡	.59‡	2.04‡	.....	82.00	134.00	.51	2.04	....	....	....	....
New Orleans	45.00	.23	.41	1.60	.....	67.00	.....	.47	1.67	....	....	....	....
New York	46.00	.28	.55	2.35	6.35	.....	.....	.55	2.00	57.50*	47.50*	54.375*	43.75*
Philadelphia	43.00	.336	.648	2.835	8.68	175.00	210.00	.54	1.80	52.37*	41.35*	53.39*	42.57*
Pittsburgh	49.00	.182‡	.351‡	1.62‡	4.92‡	69.00	108.00	.75c	1.75	69.5	61.5	67	58.5
St. Louis	46.00	.258	.459	1.83	3.96	85.00	170.00	.80	2.00	57.125	47.125	54	43.375
San Francisco	47.00	.29L	.522L	2.088L	5.67L	103.50	172.50	.45	2.20	53.69	[illegible]	50	39
Seattle	48.50	.4225	.63†	3.06†	7.55†	85.00	200.00†	.50†	1.80	65.80	57.25	66.75	56.30

*b. & s. class B and heavier, C/L lots, 200 tons and over. Burlington, N. J. (base) $43.00. Gas pipe and class A, $3 per ton additional, 4-in., $3 per ton additional. 30 in. and larger usually $2 per ton less.

#Discounts from standard list for delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 8½c; ⅜ in. 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92.

‡f.o.b. †Less 30% in C/L Lots. c Concrete Culvert pipe reinforced. dDouble strength. lList to dealers. L list. tSales & municipal taxes extra

[a]2½ to 3 in. [s]Resale price to consumer, car load lots shipped from mill.

LUMBER AND TIMBER—PER M FT. B.M., CARLOAD LOTS F.O.B.

		SHORT LEAF YELLOW PINE AND DOUGLAS FIR									LONG LEAF Y. P.	
		All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft.									Merchantable grade up to 20 ft.	
		1x6,[s]	1x8,[s]	2x4,[s]	2x6,[s]	2x8,[s]	2x10,[s]	3x12,[R]	6x12,[R]	12x12,[R]	2x12,[R]	12x12,[R]
Atlanta	Southern Pine	$16.50	$16.50	$16.50	$18.50	$18.50	$20.00	$24.00	.....	.....	$38.50	$38.50
Baltimore	Southern Pine	23.50	24.50	27.50	26.50	27.00	29.00	37.50	.....	.....	55.00	57.00
	Douglas Fir	29.50	29.50	28.50	29.50	28.50	28.50	30.50	$29.00	$29.00	.....	.....
Birmingham	Southern Pine	21.00	21.00	22.00	20.00	21.00	23.00	30.00	30.00	28.00	.....	.....
	Long Leaf	22.00	22.00	25.00	24.00	25.00	28.00	45.00	.....	.....	45.00	45.00
Boston	Roofers N.C. Pine	28.00	28.00	33.00†	35.00†	49.00†	60.00†	73.00†	.....	.....	73.00	73.00
	Douglas Fir	27.00	27.00	31.00	33.00	35.00	37.00	40.00	40.00	41.00	.....	.....
Chicago	Southern Pine	29.00	29.50	33.50	32.50	32.50	35.50	45.50	.....	.....	54.50	54.50
Cincinnati	Southern Pine	25.50	25.50	26.50	26.00	27.00	29.00	43.00	.....	.....	45.50	55.50
	Douglas Fir	.....	.....	.....	.....	.....	.....	43.75	43.75	43.75	.....	.....
Cleveland	Southern Pine	30.00	32.00	38.00	32.00	36.00	38.00	49.00	44.00f	46.00f	52.00	64.00§
Dallas	Southern Pine	d28.35	30.60	31.50	29.80	30.15	30.15	50.00	82.50	66.50	42.75	67.95
Denver	Douglas Fir	42.00	42.00*=	43.00*	43.00*	43.00*	47.00*	52.00*	56.00*	61.50	.....	.....
Detroit	Southern Pine	27.50	27.50	27.50	27.50	27.50	31.25	38.50	.....	.....	32.50	44.50
	Douglas Fir	.....	.....	.....	.....	.....	.....	43.50	43.50	44.00	.....	.....
Kansas City	Southern Pine	25.50	26.50	26.50	25.50	26.50	27.00	35.00	.....	.....	50.00	60.00
	Douglas Fir	28.50	29.00	29.00	26.50	27.50	28.00	35.00	37.00	37.00	.....	.....
Los Angeles	Douglas Fir	31.00„	31.00„	31.00„	31.00„	31.00„	31.00„	38.00„	48.00y	41.00y	.....	.....
Minneapolis.c	Western Pine	45.00*	51.50*	50.00*	41.00*	41.00*	42.00*	.....	.....	.....	58.00*[a]	.....
	Douglas Fir	42.00*	42.00*	43.00*	43.00*	43.00*	43.00*	55.00*	59.50*	59.50*	54.00	.....
Montreal	Pine	45.00	45.00	49.00	47.00	48.00	58.00	.....	.....	.....	.....	.....
	Douglas Fir	39.50	39.50	40.00	40.00	40.00	41.50	42.00	42.00	42.00	82.00	76.00
New Orleans	Southern Pine	23.50	25.50	28.00	25.00	27.00	25.50	38.00	.....	.....	44.00	54.00
	Douglas Fir	28.50	30.00	33.00	29.00	32.00	33.50	37.00	.....	.....	.....	.....
New York	Southern Pine	33.00*	34.00*	33.00*	34.00*	34.00*	38.00*	45.00*	.....	.....	72.50*	72.50*
	Douglas Fir	.....	.....	37.00*	37.00*	35.00*	38.00*	40.00*	43.00*	43.00*	.....	.....
Philadelphia	Southern Pine	30.00	31.00	32.00	32.00	33.00	34.00	36.00	.....	.....	36.00	42.00
	Douglas Fir	45.00	45.00	45.00	45.00	45.00	45.00	45.00	42.00	42.00	.....	.....
Pittsburgh	Southern Pine	30.50	31.90	37.65	33.75	36.52	37.50	47.75	.....	.....	57.50	57.50
	Douglas Fir	38.52	39.70	39.70	38.55	39.10	39.38	53.25	53.25	53.25	.....	.....
St. Louis	Southern Pine	28.50*x	29.50*x	29.50*x	28.50*x	29.50*x	30.50*x	46.00*x	.....	.....	.....	.....
	Douglas Fir	.....	.....	.....	.....	.....	.....	.....	54.00*x	54.00*x	71.00	70.00
San Francisco	Douglas Fir	20.50'	20.50'	21.00'	21.00'	21.50'	22.50'	22.00'	22.00'	22.00'	.....	.....
Seattle	Douglas Fir	15.50	15.50	15.50	14.50	14.50	14.50	21.00	20.00	20.00	.....	.....

*Delivered. †Spruce. ‡Long-leafed Y.P. §Norway Pine. ^Northern Pine. =Native. tAt ship's tackle. „Yard prices. d10% Disc. taken off. x5M ft. or less [s]S4S. [R]Rgh. cContractors in Minneapolis and St. Paul get 15% disc. from list. f Douglas Fir.

CURRENT BUILDING AND CONSTRUCTION WAGE RATES PER HOUR

	Bricklayers	Carpenters	Structural Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$0.70/1.125	$0.40/.90	$0.60/1.25	$0.75/1.50	$0.60/1.00	$0.30/.40	$0.30/.40
Baltimore	1.25	1.10	1.37½	1.25	1.25	.45	.45
Birmingham	1.00	1.00	1.25	1.125	1.00	.30/.40†	.30/.40†
Boston	1.30	.70/1.175	1.20	.90/1.425	1.375	.50/.625	.50/.70
Cincinnati	.80/1.375	.65/1.20	1.25	1.00/1.25	.80/1.375	.45	.45
Chicago	1.50	1.50	1.50	1.50	1.50	.95	.95
Cleveland	1.375	1.25	1.25	1.25	1.375	.82	.82
Dallas	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.25/.40	.25/.40
Denver	1.10	1.10	1.10	.....	.....	.625	.625
Detroit	1.25	.90/1.00	1.125/1.25	1.00/1.25	1.25	.50/.75	.50/.75
Kansas City	1.325	1.125	1.25	1.25	1.325	.70	.45/.50
Los Angeles	1.10	1.10	1.125	1.125	1.25	.50	.60
Minneapolis	1.25	1.00/1.10	1.00/1.25	1.00/1.25	1.35	.60/.75	.60/.75
New Orleans	1.00	.75	1.00	1.00	1.25	.30/.40	.30/.40
New York	1.50	1.40	1.475/1.65	1.50/1.5625	1.50	.82½	.50/.80
Philadelphia	.35/1.50	.65/1.10	.70/1.375	.90/1.80	1.10/1.37	.35/50	.40/.50
Pittsburgh	1.50	1.25	1.375	1.00	1.50	.70	.50
St. Louis	1.50	1.25	1.47	1.35/1.47	1.50	.78½	.35/.78½
San Francisco	1.50	1.125	1.37½	1.12½	1.50	.875	.60
Seattle	1.00	1.00	1.25	1.25	1.25	.60	.60
Monteral	.70	.60	.80	.55	.70	.35	.40

Skilled Avg: (Bricklayers, Carpenters, Ironworkers) $1.159 Common Avg. $0.569 † PWA.